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NYASALAND PROTECTORATE



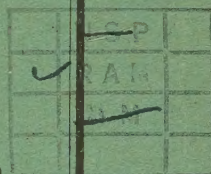
Annual Report
of the
Department of Agriculture
for the
Year 1957/8
(PART II)

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DEPARTMENT OF AGRICULTURE

ANNUAL REPORT FOR THE YEAR 1957/8

(PART II)

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INTRODUCTION

This year's Report is in form similar to its predecessors and contains all the important results of investigational work carried out by the Department of Agriculture during the Season 1957/58.

A new section on Irrigation has been added. The irrigation studies so far carried out have brought out some very interesting facts and it appears that a good deal of investigation will be required to work out an irrigation programme for our Lower River conditions.

This year's Report shows the importance of plant breeding and selection in developing and finding the correct varieties for our climatic and soil conditions. Studies of agronomic factors have been carried out over a number of years and many of these are well known. Our task now is to exploit these factors to the full by using the best available varieties. A measure of the progress of the maize breeding programme is that our variety *Namalenga*, which was once almost top yielder, is now below the mean yield in variety trials at our experimental stations. So far, however, it remains the best combination of yield and quality which we have developed, but the progress of the maize breeding programme lays encouraging emphasis on the development of varieties which combine such qualities as disease resistance, good top coverage, good keeping quality and flint grain characteristics, with a high yield.

In the development of coffee growing in Nyasaland emphasis is also laid on the study of a large number of varieties from Kenya and Tanganyika; this work has only just started but already certain Tanganyika varieties show a greater ability to withstand our rather marginal conditions.

The new cotton variety, *Albar 637*, is now in the final stages of bulking and should be ready for issue to growers shortly. Breeding of the Albar crosses and strains continues, however, in order to improve the *jassid* resistance of the Albar group of varieties.

In the search to improve the quality of our tea crop methods of vegetative propagation of tea have been developed. This is a most important step in that a good deal of time can be saved between the selection of a bush and the growing of its progeny. It will also enable more selections to be examined and help greatly in the development of pure lines in contrast to the mixed jats now being grown.

LIST OF EXPERIMENT STATIONS AND STAFF LIST

The experiment stations in operation during the period under review, and the officers who have been in residence, are listed below:

Agricultural Research Station, Chitedze, Box 158, Lilongwe

Agricultural Research Officer	H. B. AMBROSE, B.SC. (AGRIC) (LOND), DIP. AGRIC. (CANTAB)
Agricultural Officer (Tobacco) ..	J. W. DRUMMOND, B.SC. (HONS) (EDIN), D.T.A.
Agricultural Officer (Tobacco) ..	H. ROSTRON, B.SC. (LEEDS), D.T.A. (TRIN)
Agricultural Officer (Agronomist) ..	P. BROWN, B.A. (CANTAB), D.T.A. (TRIN)
Plant Breeder	R. T. ELLIS, B.SC. (LOND), DIP. AGRIC. SC. (CANTAB)
Agricultural Chemist	R. A. WOOD, B.SC. (MANCH)
Assistant Chemist	W. D. CHONA, B.SC. (RHODES)
Farm Manager	P. F. LARKINS

Tea Experiment Station, Mimosa, Mlanje

Senior Tea Research Officer	D. L. DOWNIE, B.SC. (EDIN)
Tea Research Officer	D. H. LAYCOCK, M.SC. (LEEDS) A.I.C.T.A.
Horticulturist	I. P. SCARBOROUGH, DIP. HORT.
Farm Manager	G. A. BRIDGER

Bvumbwe Tung and Agricultural Experiment Station, Box 48, Limbe

Agricultural Officer	L. J. FOSTER, B.SC. (READING)
Agricultural Chemist	C. V. CUTTING, B.SC. (LOND), PH.D., A.R.I.C.
Laboratory Technician	R. C. PEAK
Farm Manager	E. FABIAN, N.D.A., S.D.A.

Tuchila Experiment Station, Box 28, Luchenza

Officer in Charge	A. E. PREECE, N.D.A., N.D.D., S.D.A.
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Makanga Experiment Station, Chiromo

Cotton Specialist (E.C.G.C.)	J. M. MUNRO, B.SC. (EDIN)
Farm Manager	D. F. COLLINGS, C.D.A.

Mwera Hill Experiment Station, Dowa

Officer in Charge	M. J. FURBER, B.SC. (READING) DIP. AGRIC. (CANTAB) D.T.A. (TRIN).
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Chitala Experiment Station, Salima

Officer in Charge	C. N. CAMPBELL, C.D.A.
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Mbawa Experiment Station, Mzimba

Officer in Charge	F. HIGSON
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Provincial Agricultural Officers

Southern Province	..	..	..	R. SMITH, B.A., DIP. AGRIC. (CANTAB), A.I.C.T.A.
Central Province	..	..	..	H. W. T. WEBB, B.SC. (MCGILL), A.I.C.T.A.
Northern Province	..	..	..	J. A. SANDYS, B.SC. (NOTTINGHAM)

Headquarters, Zomba

Chief Agricultural Research Officer	..	..	..	S. T. HOYLE, O.B.E., M.A. (CANTAB), A.I.C.T.A.
Entomologist	..	..	..	G. W. HEATH, B.SC. (AGRIC.) (DUNELM), PH.D. (LOND), M.I. BIOL.
Ecologist	..	..	..	G. JACKSON, B.SC. (HONS) (SHEFFIELD) DIP. AGRIC. SC. (CANTAB)
Plant Pathologist	..	..	..	D. C. M. CORBETT, B.SC. (HONS) (ABERD), DIP. AGRIC. SC. (CANTAB), D.T.A. (TRIN)
Soil Surveyor	..	..	..	A. YOUNG, M.A. (CANTAB), PH.D. (SHEFFIELD)

Cotton Pest Research Scheme

Officer in Charge (Gatooma)	..	..	..	J. P. TUNSTALL, B.SC. (HONS), DIP. AGRIC. (READING), A.R.C.S.
Entomologist (Gatooma)	..	..	..	G. A. MATTHEWS, B.SC., A.R.C.S., F.R.E.S.
Entomologist (Makanga)	..	..	..	R. C. H. SWEENEY, M.I. BIOL., F.R.E.S.

MAIZE

Breeding Work

INBREEDING

Inbreeding of established lines continued, the most advanced group growing as S 9 plants. No further selection was made for disease resistance, due to the light attacks of leaf rust experienced.

Four hundred and thirty-one lines in various stages of inbreeding were grown and 1,500 self pollinations made.

TEST TOP CROSSES

The top crosses tested this season all had the flint Synthetic Variety No. 7 as pollen parent and local inbreds as female parents. Most of the female parents were from lines tested in previous years in combination with the open pollinated variety Namalenga as the pollen parent.

The results of the present trial show very good agreement with previous results. The most striking expression of this is that top crosses with inbreds from Likuni Family 18 were in first and second places in the order of yield (they have occupied similar positions in two of four previous trials). The highest yielding cross gave the equivalent of 5,962 lb. grain/acre and the lowest 3,712 lb. Control variety Namalenga gave 4,447 lb.

The series of top cross yield trials carried out over the past six years now provides good evidence as to the general combining ability of the locally bred inbred lines.

HYBRID YIELD TRIAL

Included in this trial of 125 treatments were double cross and single cross hybrids between local and introduced material and of local material only. Controls were of Southern Rhodesian hybrids and standard varieties. The trial was distinguished because of its very high yield. From the area of 0.775 acre 26½ bags of grain were harvested, being the equivalent of 6,883 per acre.

The chief value of this trial was the discovery of another strain from Mexico—H.501—which combines with certain local inbred lines to give hybrids of very high yield and with acceptable grain and cob characteristics. Two other Mexican strains H.505 and SLP.20.66B and the Southern Rhodesian inbred N.2656 were shown, as in the past two seasons, to be excellent combiners with local lines.

TABLE I
Maize Hybrids Yield Trial, 1957/58

15 Treatments only out of 125				Yields of Grain lb./acre	
R5115 × H501 (Mex)	..	..	..	..	10,291**
S.R.55 3 way hybrid 46	..	..	..	..	10,017*
V520C (Mex) × R5115	..	..	..	..	9,694*
N5191 × N2656 (SR)	..	..	..	..	9,613**
N2656 (SR) × N5191	..	..	..	..	9,436**
H501 (Mex) × L4503	..	..	..	..	8,984**
Namalenga × S.L.P.20.66B (Mex)	..	..	..	..	8,903***
L5079 × H501 (Mex)	..	..	..	..	8,888*
(H505 (Mex) × R4119) × (N2656 (SR) × R5125)	..	..	..	..	8,630***
SLP 20.66B (Mex) × L4161	..	..	..	..	8,355***

15 Treatment only out of 125					Yield of Grain lb./area	
H501 (Mex) × R5112	..	..	..	..	..	8,323***
H501 (Mex) × R5115	..	..	..	..	..	7,323***
Namalenga	..	..	..	..	..	6,468***
SLP 20.66B	..	..	..	..	..	5,113**
Local Unselected	..	..	..	..	..	5,097***
Least significant difference (P=0.05)					..	1,113
C. of V.	..	..	..	..	..	14%
*** Very good quality						
** Marginal quality						
* Poor quality.						

Good quality is as important as high yield: data are now being accumulated to show which of those lines will combine to give high yield with quality.

LOCAL CROSSES YIELD TRIAL

This was a trial of 84 double cross and single cross hybrids mainly between inbreds of local origin but containing also many hybrids between local inbreds and the Southern Rhodesian inbred N.2656. This trial again demonstrated the superiority of this latter type of hybrid over those containing local inbreds only. The mean yield of 25 single and double crosses involving local inbreds and the Rhodesian inbred was equivalent to 7,081 lb. grain/acre while that of 51 crosses involving the same local inbreds only was 5,581 lb.

The eight principal inbreds when grown as inbreds gave a mean yield of 2,403 lb. and occupied the eight bottom positions in the order of yield. One of these inbreds R 6105 was not significantly different in yield from the Local Unselected variety.

VARIETY TRIALS

Variety trials were conducted at Chitedze, Mbawa, Tuchila, Chitala and Makanga. Plots were of 10 square yards with plants placed singly at one foot intervals. 28 treatments were included.

Despite high coefficients of variation at some stations the results are very consistent and in agreement with the indications of previous trials. A most notable feature was the success of the locally bred Hybrids Nos. 4, 5, 6, 7 and 8 and the multiple crosses described as Synthetic Varieties No. 9 F.1 and No. 10 F.1. All these are combinations of local and introduced material. Local Hybrid No. 7 is not only the highest yielding hybrid of the group but also has flint grain and long husks and is potentially useful for commercial production. Of the others some have doubtful grain and cob quality and only L.H. No. 5 and No. 6 and S.V. No. 10 are worthy of further test.

Synthetic Varieties Nos. 8 and 12 are potentially valuable. The yield of S.V. 8 is good but its quality must be improved before it can be of general use. The quality of S.V. 12 is satisfactory as it is predominantly composed of local inbred lines, but it remains to be seen to what level its yield will drop in advanced generations.

It is regretted that valid comparisons cannot be made between the F.1 and F.2 yields of S.V. No. 7 and L.H. No. 2 as the F.1 used in both cases was old and did not germinate well.

Mlanda is a synthetic variety with resistance to *Puccinia polysora* rust. Its grain quality is especially good and its F.1 yield was satisfactory, particularly at Makanga, for which area it was developed.

It is a measure of the progress being made in the maize breeding programme that Namalenga, which was once almost the top yielder, is now below the mean yield at all stations. It must be noted however that for overall combination of yield and quality this open pollinated variety is still the best available for general use.

TABLE II
Maize Variety Trial
Yields of grain (lb./acre)

		<i>Chitedze</i>	<i>Tuchila</i>	<i>Mbawa</i>	<i>Chitala</i>	<i>Makanga</i>	<i>Mean yield all trials</i>
1. Nyanga (SV6F2) ..	..	6,149	2,694	2,413	2,518	1,516	3,058
2. Mkanda (SV7F2) ..	..	6,017	2,304	1,898	2,084	1,164	2,693
3. Namalenga ..	..	7,001	3,360	2,699	2,584	1,759	3,481
4. Ngale (TC26F1) ..	..	7,513	3,371	3,024*	3,401*	1,759	3,814
5. Mtanda (LH5) ..	..	8,321	3,766	3,395	3,037*	2,566*	4,217
6. Adziko ..	..	6,796	2,863	2,747	2,660	1,148	3,243
7. Zochulukitsa ..	..	7,849	4,308*	3,141*	3,122*	1,987	4,081
8. Local Unselected ..	..	6,195	2,794	2,478	2,855	2,057	3,276
9. LH No. 4 ..	..	8,282	3,705	3,506	3,238*	2,165	4,179
10. TC26 F2 ..	..	6,310	1,882	2,399	1,764	1,012	2,673
11. STCM F1 ..	..	7,487	2,935	3,540*	3,247*	2,024	3,847
12. Mlonda ..	..	7,371	3,061	2,649	3,179*	2,685*	3,789
13. GTC SV ..	..	6,464	2,875	2,457	2,672	936	2,894
14. SV6 F1 ..	..	6,650	3,020	2,625	3,107*	1,462	3,373
15. SV7 F1 ..	..	5,687	2,214	2,445	3,130*	1,532	2,582
16. LH6 ..	..	7,902	4,453*	3,129*	3,384*	2,609*	4,295
17. LH7 ..	..	9,424*	4,717*	3,432*	3,396*	2,891*	4,772
18. LH8 ..	..	8,327	4,553*	3,803*	3,551*	2,647*	4,576
19. SV 9 ..	..	8,303	4,089*	2,527	3,351*	1,992	4,050
20. SV 10 ..	..	8,420	4,844*	3,553*	3,318*	2,679*	4,562
21. SV 11 ..	..	6,357	3,035	2,543	2,692	1,375	3,200
22. SV 12 ..	..	7,645	3,823	2,894	2,775	2,257	3,879
23. SRHy 8 ..	..	8,780*	3,988	3,248*	3,286*	2,631*	4,387
24. LH2 F1 ..	..	6,079	2,966	2,926	2,794	1,386	3,230
25. LH2 F2 ..	..	5,970	2,242	2,801	2,013	1,207	2,847
26. SV8 ..	..	8,278	3,904	3,053*	3,745*	2,079	4,212
27. SV2 F5 ..	..	6,036	3,150	2,801	2,520	1,808	3,263
28. Makanga Selection ..	..	—	—	—	—	2,393	2,393
29. Chitala Selection ..	..	—	—	—	2,894*	—	2,894
Mean ..	..	7,245	3,367	2,894	2,942	1,901	—
Least sig. diff (P=0.05%) ..	..	934	768	863	858	432	—
C. of V. ..	..	11%	20%	26%	25%	15%	—

* Top yielding varieties not differing significantly from one another.

DISTRICT MAIZE TRIALS

One lb. of seed of each of seven varieties (treatments 1-7 of the Maize Variety Trial—see Table II) were issued to 140 African cultivators most of whom were Master Farmers. With some supervision from the District Staff the growers were asked to plant the varieties in adjacent plots and to comment as to their performance and quality.

With the exception of the Southern Province where Namalenga was clearly preferred the order of preference was extremely variable. It would appear that in the Central and Northern Provinces the preference for the flint grains of Nos. 1, 2 and 6 counter-balanced the superior yield but more denty grain of Nos. 3, 4, 5 and 7. Namalenga's good tip coverage was appreciated and this probably was its main advantage. It drew some adverse comments as to its grain quality.

Plot sizes and weights of maize harvested were recorded for 15 growers in the Southern Province, 35 in the Central and 18 in the Northern Province. The results are given in Table III. Yields were generally at a very satisfactory level and the order of yields of varieties closely followed that obtained in the formal yield trials at the Experiment Stations. Mtanda stands out as being the best yielder and this was to be expected as it is a double cross hybrid; unfortunately its grain is denty and its tip coverage not good. The same remarks apply to Zochulukitsa, another high yielder. Ngale (Top Cross 26) maintained generally a small lead over Namalenga but as better material is now becoming available it will probably not be used much more. Nyanga is the F.2 of a double cross hybrid between four local inbreds and its reasonable yield and good quality give support to the view that this is a possible method for producing improved seed. Adziko is a combination of unimproved local material and Mkanda, the F.2 of an early synthetic variety of eight local inbreds.

TABLE III
District Maize Trials, 1957/58
Mean Yields per acre/grain

Province	1 Nyanga	2 Mkanda	3 Nama- lenga	4 Ngale	5 Mtanda	6 Adziko	7 Zochu- lukitsa	All varieties	Least Sig. Diff.
Southern ..	2,357	2,016	2,413	2,326	2,491	2,158	2,463	2,320	394
Central ..	3,029	2,739	3,009	3,177	3,567	2,906	3,273	3,100	271
Northern ..	2,704	2,381	2,544	2,830	3,003	2,551	2,882	2,699	325
	2,696	2,379	2,655	2,778	3,020	2,538	2,873	—	—

MULTIPLE CROSSES

A series of crosses was made between 29 varieties, synthetic varieties and hybrids which have proved themselves over the past five years to have good qualities. In all 2,500 crosses were made which will be combined into synthetic varieties.

BREEDING FOR DISEASE RESISTANCE

Helminthosporium turcicum, Leaf Blight

A large programme of crossing and back crossing was continued with the object of improving the resistance to *Helminthosporium turcicum* of the best breeding material. New sources of resistance used for the first time come from Mexico, Columbia and Guatemala.

Puccinia polysora, Leaf Rust

Interest centred on the performance of the synthetic variety with resistance to *Puccinia polysora*, the formation of which was described in the report for 1957/58. This variety is now known as Mlonda.

The incidence of the rust was very spasmodic and even on Makanga Experiment Station, in the area most favourable to the disease, it was only severe on some parts of the station and absent on others. A light attack occurred at the Agricultural Research Station, Lilongwe, and the disease was noted at various places in Mlanje, Cholo, Chikwawa and Port Herald Districts. No survey was attempted.

It is seen from the maize variety trial reported above that the yield of Mlonda was satisfactory, especially at Makanga. Other yield data from unreplicated plots are given below in Table IV.

TABLE IV
Yield of Mlonda Maize 1957/58 in the Lower River Area
lb./acre grain

Locality	Mlonda	Local maize
Sankulani	980	790
Nyamandoto	1,400	1,350
Ngabu	2,785	2,170
Ngabu	1,670	1,320
Thudzu	3,000	2,070
Katungu	1,314	860
Mulilima	2,714	1,930
Nyamphota	1,970	1,340

Makanga Experiment Station	Mlonda	Makanga Selection
Planted October (irrigated) ..	2,341	2,075
Planted November (irrigated) ..	2,299	2,063
Planted December	2,031	1,464

These yields must be regarded as satisfactory even when it is borne in mind that Mlonda was grown this season as an F.1 and when grown again some reduction in vigour and yield may be expected. It is hoped that this will not be great, however, as Mlonda has a complex pedigree in which the following diverse strains appear: Local open pollinated variety Makanga Selection; Local Inbreds R 3363, L 3198; East African open pollinated varieties Muratha and K 8; Mexican inbred SLP 20-4A, Mexican Hybrid (L 11.123-2-1-8x Coahuila 8-56A-4-2); Columbia variety "Col 2".

The component inbreds of Mlonda were grown and some selection done with a view to improving their resistance to *Helminthosporium turcicum*.

Trials were held at Chitedze and Makanga of a series of crosses between high yielding strains and E.A.A.F.R.O. produced lines with resistance to *Puccinia polysora*. The mean yield at Chitedze was 6,092 lb. and at Makanga the high figure of 3,286 lb. of grain per acre. The highest yielding combinations with acceptable cob and grain quality will form the basis for further work.

TRIAL TO ASSESS LOSS OF YIELD DUE TO LEAF DISEASES

Trials were held at Chitedze and Makanga to compare the yield of maize open to natural infection by leaf diseases with that regularly sprayed with Zineb (zinc ethylene bi-dithiocarbamate) to control leaf diseases. The spraying was done twice weekly, starting when the plants were six weeks old and continuing till maturity, at the rate of 2 lb. Zineb in 200 gallons of water per acre.

At Makanga there was very little leaf disease on this particular experiment and no significant difference in yield was shown by spraying.

At Chitedze there was a light infection of *Helminthosporium turcicum*, a slight incidence of *Puccinia sorghi* and between seed setting and maturity a light attack of *Puccinia polysora*.

On the sprayed plots the incidence of disease was reduced to an occasional lesion or pustule on scattered plants.

There was a statistically significant reduction in yield on the unprotected plots as compared with the protected ones of 7.3 per cent. which was equivalent to 509 lb. of grain per acre.

MAIZE POUNDING EXPERIMENT

In the report for 1956/57 an experiment was described which included the chemical analyses of maize flour prepared in different ways. It pointed out that when maize flour (*ufa*) is prepared in the traditional manner, a large proportion of the crude protein and oil contained in the grain is thrown away. It was suggested that from the nutritional point of view this might be worth further investigation.

Information has now been received from the Applied Nutrition Unit of the London School of Hygiene and Tropical Medicine that due to its greater digestibility and the changes which take place during the soaking of the grain in the making of *ufa*, this latter is nutritionally preferable to whole dry milled flour. It would appear that the majority of Africans who rely on maize for over 80 per cent. of their total food calories are right to prefer the use of the traditional methods of preparing flour even although they do entail the discarding of a proportion of the grain.

Agronomy

MAIZE FERTILIZER TRIALS

Federal Fertilizer and Population Trials

The results of this season's Federal Fertilizer Trials at five stations are given below:

TABLE V
Response of Maize to Nitrogen, Phosphate, Potash and Population density
Variety: Local Selection *Yields: lb./acre grain*

<i>Treatment</i>				<i>Chitedze After Napier</i>	<i>Chitala</i>	<i>Tung Station After Rhodes</i>	<i>Tuchila After Rhodes</i>	<i>Mbawa</i>
S ₀ 12,100 plts	..	..	..	4,662	2,534**	2,033	2,762*	2,470
S ₁ 14,520 plts	..	..	..	4,722	2,635**	1,898	2,554	2,204
S ₂ 16,940 plts	..	..	..	4,834	2,135	2,001	2,356	2,249
N ₀ Nil	..	..	..	4,353	1,282	945	1,775	1,311
N ₁ 150 lb. S/A	..	..	..	4,840**	2,572***	1,786***	2,580***	2,225***
N ₂ 300 lb. S/A	..	..	..	5,024***	3,450***	3,201***	3,317***	3,386***
P ₀ Nil	..	..	..	4,505	2,405	2,060	2,585	2,286
P ₁ 125 lb. Supers	..	..	..	4,730	2,454	1,880	2,512	2,398
P ₂ 250 lb. Supers	..	..	..	4,983*	2,445	1,992	2,575	2,238
K ₀ Nil	..	..	..	4,707	2,157	1,974	2,628	2,254
K ₁ 50 lb. KC1	..	..	..	4,763	2,708	1,978	2,482	2,361
Mean	..	..	..	4,735	2,435	1,974	2,557	2,307
L.S.D.	..	..	..	306	274	534	312	314
Coeff. of variation	..	..	..	9.3%	16.3%	38.8%	17.8%	19.7%

As in last year's results there have been large responses to sulphate of ammonia, especially where control yields have been low. Except at Chitedze, where surprisingly good yields were obtained after a poor start on a newly ploughed out unfertilized Napier grass ley, there has been no fall off in response up to the limit of fertilizer applied, i.e., 300 lb. per acre sulphate of ammonia, whereas last year a marked fall in the response was found between the 250 lb. and 500 lb. rate per acre with this fertilizer. There has been a significant, but hardly economic, response to superphosphate, but only after a heavily utilized and unfertilized ley at Chitedze. Potash comparisons were made only between blocks, but no differences were found except at Chitala where there may be a slight response to potash. Plant population

affected the yields significantly only at Tuchila and Chitala, as they did last year, but whereas the hybrid maize then tended to give higher yields at the higher population levels, the local selections seem to do better with a lower population of between 12,000 and 14,000 plants per acre. There were again no interactions between rate of fertilizer and density of population. For a given level of fertilizer, increased plant density was counteracted by smaller cobs and more "passenger plants".

TIME OF APPLICATION OF NITROGEN

Past experiments in Nyasaland have shown that for the small dressings normally advocated it makes little difference when nitrogen is applied to maize so long as the dressing is put on within four weeks from planting. Southern Rhodesian practice is to apply the bulk of the nitrogen at knee height, i.e., about 30 days from planting. This series of experiments was put down at four stations to check past results in Nyasaland. Sulphate of ammonia was therefore applied at planting (E), at 30 days from planting (M), and at first tassel (L) in different proportions.

TABLE VI
Effect of Time of Application of Nitrogen on Maize Yields

Variety: Local Selections

Yields: lb. per acre

<i>Treatment</i>						<i>Chitedze After Napier Ley</i>	<i>Chitala After Arable</i>	<i>Tuchila After Rhodes Ley</i>	<i>Mbawa After Makarikari Ley</i>
Sulphate of Ammonia:—									
Nil	..	..	..	..	..	4,352	963	2,228	1,022
100 lb./acre	..	..	..	..	..	4,694	1,636***	2,534	1,739***
200 lb./acre	..	..	..	..	..	4,854*	1,920***	2,592*	2,166***
Applied:									
E: M: L	..	..	..	..	..	4,815	1,846	2,469	1,967
0: 1: 0	..	..	..	..	..	4,420	1,735	2,612	1,816
1: 1: 0	..	..	..	..	..	4,811	1,714	2,626	2,285*
1: 2: 1	..	..	..	..	..	4,930	1,772	2,518	2,040
2: 1: 1	..	..	..	..	..	4,895	1,820	2,599	1,668
Mean	..	..	..	..	..	4,736	1,705	2,532	1,871
L.S.D.	..	..	..	..	..	387	180	317	350
Coef. of Var.	..	..	..	..	..	8.1%	11.7%	12.3%	15.5%

It would appear to make very little difference when nitrogen is applied at the rates at present advocated in this country. To save labour one application, either at planting or after the first weeding, seems as good a method as any.

18:9:0 FERTILIZER MIXTURE

This new mixture tested against equivalent sulphate of ammonia and super-phosphate and against sulphate of ammonia alone up to the rate of 400 lb. per acre showed itself to be as effective as equivalent quantities of the standard fertilizers. At Tuchila the new mixture was no more effective than equivalent sulphate of ammonia. At Chitedze, where there was a slight phosphate deficit after a Napier grass ley and on a highly phosphate deficient soil at Mbawa, the mixture was very much better than sulphate of ammonia alone, which is the standard fertilizer at present sold to African farmers. The new mixture stores and handles quite well, being granular in form. There is a good case for replacing sulphate of ammonia by this N.P. mixture in Mzimba District and certain other isolated phosphate deficient areas.

DISTRICT FERTILIZER TRIALS

Thirty-three more trials of 3 × 3 N.P. design were successfully conducted in gardens throughout the territory, 18 in Central Province, 8 in the Northern Province and 7 in the Southern Province. Large and economic responses to sulphate of ammonia at both 100 and 200 lb. per acre were obtained at most sites. The exceptions to this rule were alkaline clay soils and alluviums of the Lower Shire and Karonga coastal plain and some of the better cultivated red loams of the Central Province which were in good natural heart. There were responses to superphosphate at 200 and 400 lb. per acre but only after a heavily utilized Napier grass ley at Chitedze and on some soils in Mzimba District. No significant interactions occurred.

Combining the figures obtained to date from these 3 × 3 district trials, average response curves can be calculated for various soil types and districts using the expression:

$$R = d(1 - 10^{-kx})$$

where R = response to x lb. of sulphate of ammonia.
d = limiting response for any soil series
k = a constant
x = rate of application of sulphate of ammonia.

TABLE VII
Calculated average Responses to levels of Sulphate of Ammonia applied to various Soil Types

Variety: Local

Yields: lb. per acre grain

Area and Soil Type	No. of Expts.	Level of sulphate of ammonia applied per acre						Mean control yield
		50	100	150	200	250	300	
Lilongwe/Dowa plateau—red sandy clay loams ..	19	236	432	546	732	846	940	2,662
Lilongwe/Dowa plateau—brown and grey sandy loams on dambo slopes ..	10	1,117	1,655	1,926	2,026	2,037	2,047	1,031
Dedza Highland—red loams ..	2	265	486	664	808	923	1,019	801
Dedza/Dowa Lake-shore ..	4	401	725	989	1,202	1,376	1,516	986
<i>Brachystegia country</i>								
Kasungu/Fort Manning—Sandy loams and sands ..	2	255	581	863	1,154	1,410	1,709	1,042
Mzimba Chinunka ..	9	481	833	1,093	1,284	1,424	1,547	1,481
Rumpi—River bank soils ..	3	357	689	968	1,218	1,430	1,622	2,280
Karonga Lake-shore ..	3	No significant responses						1,516
Economic response with S/A at 3d per lb. and maize at 3d per lb. ..	—	250	500	750	1,000	1,250	1,500	—

These show that sulphate of ammonia is well worth applying except on certain alluvial and riverine soils in the Lower Shire and Karonga Lake-shore, on the richer and better cultivated red soils of the Dowa Lilongwe plateau, and on those soils of Dedza Highlands so far tested, where there seems to be a limiting factor which is not phosphate. In Mzimba the sulphate of ammonia should be replaced by a N.P. mixture.

One hundred lb. per acre probably gives the most economic return, but dressings up to 200 lb. per acre of sulphate of ammonia are usually worth while.

RESIDUAL FARMYARD MANURE TRIAL

The trial put down in the 1956/57 season to compare farmyard manure made with and without a starter of soil against inorganic fertilizers was continued this season. The starter last season made the farmyard manure more effective, and it was thought that it might have speeded the rotting of the organic matter, so liberating more nitrogen for the plants. If this were so the manure made without soil might be more effective in the second year. In fact the manure made with soil was again more effective than the other in its residual response, there being no significant residual responses from the artificial fertilizers.

TABLE VIII
Direct and Residual Effects of Organic Manure on Maize
Variety: *Namalenga* Yields: lb. per acre grain

<i>Treatment</i>	<i>Year of application</i> 56/57	<i>Residual effects</i> 57/58
F.Y.M. made with soil	3,484	1,843
F.Y.M. made without soil	3,226	1,726
Control	2,399	1,287
L.S.D.	665	413
Coefficient of Variation	15.3%	20.5%

On the poorer soils farmyard manure has a markedly beneficial effect for several seasons. In Instructors' gardens in the Northern Province unfertilized crops of maize gave 3 bags per acre, those given 100 lb. per acre sulphate of ammonia gave 7 bags per acre, while one receiving approximately 5 tons per acre of F.Y.M. as well as the sulphate of ammonia gave 19 bags per acre grain. On rich soils, newly cleared from bush and containing a considerable amount of undecayed organic matter, it may have little effect unless extra artificial nitrogen is given. Other things being equal farmyard manure should be applied in a well rotted condition to prevent nitrogen being locked up by the bacteria responsible for decay.

MAIZE WITH KHOLA MANURE UNDER IRRIGATION

At Makanga maize was grown under irrigation with nil, 10 tons per acre and 20 tons per acre of khola manure. The mean yield per acre was 2,468 lb. grain and there was no response to the dressings of khola manure.

TIME OF PLANTING AND WEEDING

A number of plots at Chitedze, some planted dry on 18th November, 1957, and some about two weeks after the first rains on 19th November, 1957, were divided in half, one side being weeded early and the other weeded late. All plots received another weeding later as required. The effects of late planting and late weeding were very marked.

TABLE IX
Effects of Late Planting and Late Weeding on Maize Yields
Variety: *Namalenga* Yields: lb./acre grain

	<i>Weeded early</i> 8/1/58(E) and 14/1/58(L)	<i>Weeded late</i> 23/1/58	<i>Difference</i>
Planted early (5 reps)	3,816	2,866	—950
Planted late (4 reps)	2,499	1,878	—621
Average of all 9 replications	3,231	2,427	—804

SPACING OF MAIZE

As mentioned above, three densities of population were incorporated in the Federal Fertilizer Trials. Increase in population did not increase yield and an analysis of the yield factors is given below:

TABLE X
Analysis of Yield factors at three population densities of Maize
Variety: *Local Selections*

Station	Measurement	S_0 $3' \times 14.5'' \times 1$	S_1 $3' \times 12'' \times 1$	S_2 $3' \times 10.25'' \times 1$
Chitedze	Yield lb./acre grain	4,662	4,722	4,834
	Actual plants/acre	12,440	14,620	16,660
	Cobs harvested/acre	10,860	12,060	13,290
	Wt/cob lb. grain	.429	.392	.364
Chitala	Yield lb./acre grain	2,534**	2,635**	2,135
	Actual plants/acre	11,900	14,160	16,620
	Cobs harvested/acre	9,180	10,220	10,220
	Wt/cob lb. grain	.275	.256	.209
Tuchila	Yield lb./acre grain	2,762*	2,554	2,356
	Actual plants/acre	10,250	13,420	13,970
	Cobs harvested/acre	10,580	11,320	11,890
	Wt/cob lb. grain	.261	.226	.198
Tung Station ..	Yield lb./acre grain	2,033	1,898	2,001
	Actual plants/acre	12,040	14,440	16,850
	Cobs harvested/acre	8,620	9,290	10,260
	Wt/cob lb. grain	.236	.204	.195
Mbawa	Yield lb./acre grain	2,470	2,204	2,249
	Actual plants/acre	11,430	13,220	15,270
	Cobs harvested/acre	9,280	9,930	10,040
	Wt/cob lb. grain	.27	.22	.20

It would not appear to be worth while aiming at a population of more than 14,500 either in a $3' \times 3' \times 3$ plant, or $3' \times 1' \times 1$ plant spacing. A comparison between these two spacings was made at Chitedze using Namalenga, a maize variety which does not stand very well.

TABLE XI
Effect of Spacing of Maize Plants in a 14,500 plant population
Variety: *Namalenga* Yields: lb./grain/acre

Treatment	Yield lb./acre	Wt/cob lb.	Plants/ acre	Cobs/ acre	Plants fallen	Per cent. plants laid
$3' \times 3' \times 3$ plts.	5,171	0.561	10,200	9,220	7	17
$3' \times 1' \times 1$ plant	4,875	0.559	10,300	8,720	19	32
L.S.D. 5 per cent.	544	—	—	—	—	—

It is believed from this that the $3' \times 1' \times 1$ plant spacing offers more resistance to the wind without allowing much improvement in the strength of the prop roots. Those plants which break and fall on the ground are usually destroyed by termites as are some of those which are just laid.

METHOD OF OCTOBER PREPARATION OF GARDENS

This experiment has now been carried on for three years at each of three stations and this is the third successive maize crop taken. Sulphate of ammonia was applied at Tuchila and Mbawa so as to obtain reasonable yields.

TABLE XII
Methods of Garden Preparation in October for Maize

Variety: *Local Selections*

Yields: *lb./acre grain*

Treatment				Chitedze	Mbawa	Tuchila
Make up ridges	..	..	..	1,541	1,905	1,540
Split ridges	..	..	..	1,816*	1,862	2,043*
Bury stover	..	..	..	1,911**	2,172	2,328**
Burn stover	..	..	..	1,944**	2,114	1,822**
Mulch stover	..	..	..	1,599	1,882	1,974*
Remove stover	..	..	..	1,492	1,655	1,578
Average yield/acre	..	..	..	1,713	1,925	1,868
Coef. of Variation	..	..	..	12.5%	26.7%	16.2%

It pays to split the ridges as this gives a ridge more suited to good germination. At Chitedze this year it was most noticeable that split ridges gave a cloddy surface which allowed easy water penetration and rapid germination of the seed, while ridges which had been scuffled up had a finer surface which formed a crust under the first heavy downpours and considerably delayed germination. The better stand obtained from split ridges does not necessarily mean a higher yield. It does not pay to remove the stover unless it is to be returned to the land as manure. On the short term basis there seems to be little to choose between burning and burying the trash and stover, but there are indications that in the long run burying would be better, provided weeds and diseases do not increase. These last factors militate against the practice of leaving the stover as a surface mulch.

NITROGEN AND MULCHING TRIAL

At Makanga various nitrogenous fertilizer dressings were applied to maize with and without a mulch. This year there were responses to nitrogen, whereas there were none last year, and as is usual there was a significant increase in yield in the mulched plots.

TABLE XIII
Effect of Nitrogenous Fertilizer and Mulch on Maize at Makanga

Variety: *Makanga Selection*

Yields: *lb./acre grain*

Nitrogen Treatments				Mulch	No mulch	Mean
Nil	..	..	..	2,460	2,249	2,354
250 lb./acre S/A	..	..	..	3,166	2,784	2,975**
500 lb./acre S/A	..	..	..	3,259	2,941	3,100***
300 lb./acre N/S	..	..	..	3,027	2,487	2,757*
600 lb./acre N/S	..	..	..	3,291	2,597	2,946**
Mean	..	..	..	3,040*	2,612	2,826
L.S.D. 5 per cent. Mulch Means	..	..	..	336	Fertilizer	Means 209
Coef. of Variation	..	..	..	7.2%	—	—

The sulphate of ammonia was a better source of nitrogen than the nitrate of soda, especially where no mulch was applied. Responses of between 500 and 600 lb. per acre maize for 250 lb. per acre sulphate of ammonia are by no means economic, and the high dressings are therefore out of the question.

The response to nitrogen, unusual at Makanga, may perhaps be accounted for by the fact that the experiment was planted on land just ploughed out of unfertilized elephant grass, and was due almost entirely to an increase in cob size on those plots receiving nitrogen.

Extract from Report of the Entomologist

MAIZE STALK BORER

Little success was attained with light-traps as a means towards finding which species of moth constituted the Maize Stalk Borer in the Highland areas of Nyasaland and it has been found necessary to collect diapause larvae and keep them in the insectary for breeding out; this work will not therefore be complete until next season. So far the species collected are *Busseola fusca* Hmps and *Chilo zonellus* Swinh. In Zomba District the latter species appeared to be the dominant borer last season. It has previously been recorded from sorghum and maize, when it was erroneously named *Chilo suppressalis* Walk. One other unidentified species has been bred out and forwarded to the Commonwealth Institute of Entomology for identification.

An experiment designed to test the effectiveness of one and two applications of 5 per cent. DDT dust against Maize Stalk Borer was carried out at 4 different sites in the Highland areas of the country. The experiment was of split plot design and the main treatments consisted of 4 different planting dates, i.e., dry planting, planting with first rains, planting 14 days from first rains and planting 28 days from first rains. These main plots were then split for insecticide treatment, i. e., no insecticide, one application of 10 lb. 5 per cent. DDT per acre and 2 applications of 7½ lb. 5 per cent. DDT per acre. Insecticide treatments were carried out when the maize was 18" high at "funnel" stage. Where two applications were made the second one was made 14 days after the first. The object of the planting date treatments was to find out whether or not the early planted maize suffered a more severe attack. In the event the rains were very late in the 1957/58 season so that much of the maize crop in the Highland areas was in fact planted at a time phenologically earlier than usual. Furthermore, the Maize Stalk Borer population appeared to be lower than usual, due no doubt to the fact that the dry season was characterized by being longer and hotter than usual, thus causing a high mortality of the diapause larvae.

At only one of the three sites was the borer infestation great enough to make the experiment a success; this site was in the Dowa Hills of Central Province, an area known to suffer badly from stalk borer.

The data collected are summarized and presented below, but it should be explained that the figure (Table XIV) for mean number of bored stems for 150 plants per plot was determined in March, and that the figure is a measure of the effectiveness of the insecticide treatment. The number of bored stems will be seen to be very low, and at first sight this will be thought to show an insignificant population incapable of very much damage. However a consideration of these data in conjunction with Table XV will show that this small population did reduce the final plant stand by nearly 10 per cent. in the plots with no insecticide. It is suggested therefore that the original attack by stem borer had resulted in the death of many of the attacked plants before the counts for bored stems were made in March. It is known that at the time these counts were made that the first generation were already emerging as adults, but it is still uncertain as to whether these first generation larvae pupate in the plants they have killed or whether they migrate to more sturdy plants in order to construct their pupation chambers.

In spite of these inconsistencies between the number of bored stems and the final stand count, it will be seen that the insecticide treatment resulted in a significant decrease in the number of bored stems, whereas the planting date did not.

TABLE XIV
Numbers of Stem-bored plants (March)

			0*	1	2	Totals	Mean	
A*	..	..	4	1	Nil	5	0.3	Not significant —
B	..	..	13	3	3	19	1.0	
C	..	..	19	3	Nil	22	1.2	—
D	..	..	14	8	2	24	1.3	—
Totals	..	..	50	15	5	70	—	—
Mean	..	..	2.1	0.6	0.2	—	—	—
L.S.D. = 1.40 (P=0.01)								

* Symbols A= Dry planting.
 B= Planting first rains.
 C= " 14 days after first rains.
 D= " 28 days " " "
 O= No insecticide.
 1= 10 lb. 5% DDT/acre.
 2= 15 lb. " " " 2 applications.

The mean given is for number of bored stems in 150 plants.

TABLE XV
Final Stand Counts at Harvest (June)

			0	1	2	Total	Mean	
A	..	..	190	222	234	646	33.9	L.S.D. =9.5 (P=0.01)
B	..	..	185	204	217	606	33.7	
C	..	..	123	154	141	418	23.2	
D	..	..	54	60	48	162	9.0	—
Totals	..	..	552	640	640	1,832	—	—
Mean	..	..	23	26.7	26.7	—	—	—
L.S.D. = 3.5 (P= 0.01%)								

Mean given is for a sample of 20 plant hills, the maximum number of plants possible is therefore 60 per plot.

TABLE XVI
Yield at Harvest (lb. of Cobs)

	0	1	2	Totals	Mean	
A	596	675	730	2,001	111.0	L.S.D.
B	550	610	645	1,805	100.2	=42
C	283	364	358	1,005	55.8	(P=0.01)
D	87	124	90	301	16.7	—
Totals	1,516	1,773	1,823	5,112	—	—
Mean	63.1	73.8	75.9	—	—	—

L.S.D. = 11.7 (P=0.01).

L.S.D. = 8.6 (P=0.05).

As was to be expected the planting date treatment had a highly significant effect upon final plant stand and final yield. Two applications of DDT had a highly significant effect on yield and one application was also significant. There was no significant interaction between date of planting and insecticide either in final yield or final stand of plants and this is in accordance with the season and the pattern of borer attack.

In terms of yield of shelled maize per acre both insecticide treatments resulted in an increase of just over 20 per cent. in the early planted plots and 15 per cent. over the whole experiment. It is surprising that the treatment did not result in a proportionally greater increase on the early planted plots but as has been explained this was probably due to the peculiar season. The yield of shelled maize on the early planted untreated plots was in the region of 1,200 lb./acre and on the treated plots 1,450 lb./acre; this increase in yield was obtained for an outlay of 10 shillings to 15 shillings per acre. Further experiments are being carried out to see whether the higher rate of application is in fact necessary in a normal season.

Extract from Report of the Agricultural Chemist, Bvumbwe

At Makanga Experiment Station where the soils contain montmorillonitic clays, there has been lack of response to nitrogenous fertilizers in the form of ammonium sulphate. Although the climate (high temperatures) may have considerable effect, it was considered that nitrogen in the form of nitrate might give improved results. In connection with this, and also to assess the effects of mulching, a preliminary examination of soil samples for mineralizable nitrate nitrogen has been made.

The 1957 irrigation experiments, using ammonium sulphate and sodium nitrate are described earlier in this Report. (See Table XIII.)

The initial nitrate N in the soil before planting was 26 p.p.m. in the N/S plots and 54 in the S/A plots. Detailed sampling of the six rows in the N/S plot gave figures of 30, 18, 33, 19, 24, 29, for nitrate N. The pH was 6.4-6.5, and the soluble salts 0.1 per cent. After cropping the corresponding nitrate figures were 102-168 and 76-99. After incubation of the latter soils for two weeks the amounts of nitrate N increased to 204-244 and 124-176 p.p.m. respectively.

From a second irrigation experiment with two levels of N as ammonium sulphate only (250 and 500 lb.) similar samples were examined. Before planting, the nitrate was 15, 14 and 13 p.p.m. in the control and N₁, N₂ plots. After cropping the corresponding figures were 16-26, 25-37 and 36. When these latter samples were

incubated, the respective figures were 108–124, 96–116, and 164 p.p.m. The soluble salts increased on the high level of N, to 0.16 per cent. compared with 0.12 per cent. in the control plot. The pH also decreased from 6.3 in the control, to 6.2 with 250 lb. and to 6.1 with 500 lb. of sulphate of ammonia.

During the wet season, soils from the Mulching/N experiment of which yield details are quoted previously, were also analysed. The data for nitrate nitrogen before and after cropping are summarized below.

TABLE XVII
Nitrate N (p.p.m.)

Treatment	Before Fertilizer applied (Dec.)				After Cropping (May)			
	No mulch		Mulch		No mulch		Mulch	
	Initial	Incubated	Init.	Inc.	Init.	Inc.	Init.	Inc.
O	36	47	39	51	24	62	34	59
Sulphate ₁	32	69	39	76	34	116	36	81
S ₂	38	76	36	80	26	110	63	140
Nitrate ₁	31	63	36	57	25	91	42	94
N ²	27	39	38	59	36	108	64	112

The soils of this experiment were thus originally more uniform than in those of the irrigation area. Mulching has led to a higher level of nitrate N in the soil, although after incubation, it is seen that the effect of mulching is not so pronounced on the mineralizable nitrogen. The effect of the higher applications of N in both forms is more pronounced under mulch, which may be due to either nitrate arising from decomposition of the mulch or of its effect in reducing leaching, or to a combination of both these factors.

The samples were taken at 0–6". Samples from 6–9" were also taken to assess any variation. The nitrate figures were generally 10–20 p.p.m. less than in the corresponding top soil.

In the corresponding experiment on sorghum the figures were as given in Table XVIII. As for the maize, two composite samples were made from each pair of the four plots.

TABLE XVIII
Sorghum Expt. Nitrate N (p.p.m.)

Treatment	After Cropping (May)			
	No mulch		Mulch	
O	34	116	36	122
Sulphate ₁	37	148	48	106
S ₂	51	122	65	156
Nitrate ₁	46	106	46	124
N ²	104	202	82	136

On one of the N₂ plots, the nitrate before and after incubation was 256 and 322 p.p.m.

These figures are rather higher throughout than on the maize plot, most probably due to the different site as the experiments were not adjacent. The mulch does not appear to have caused such a difference when compared with the no mulch

plot. It should however be noted that when these samples were taken, the maize stalks had been removed—but the sorghum plants were still standing, thus giving more protection to the soil. Because of this, and other factors, it is clear that periodic sampling during the growing period would be advisable, but unfortunately, time did not permit this and the subsequent laboratory examination.

The montmorillonitic nature of the Makanga soils—which on the experimental sites referred to contain 15–25 per cent. clay—may influence nitrification, e.g., by partial fixation of ammonium ions on the clay lattice. Soils from another maize trial at Tengani, 20 miles from Makanga, were therefore examined, as these soils are much lighter, and any clay influence would be correspondingly less. The top soil contains 3 per cent. clay, and the subsoil 8 per cent., and the profile is sandy throughout to 4 feet.

The Tengani experiment contained NPK and dung treatments. The nitrate nitrogen in the various plots is shown below in Table XIX, the samples being taken after cropping.

TABLE XIX

<i>Treatment</i>	<i>O</i>	<i>Dung</i>	<i>N</i>	<i>N₁</i>	<i>NP</i>	<i>PK</i>	<i>NK</i>	<i>NPK</i>	<i>P</i>	<i>K</i>
Initial	9	14	10	15	14	12	9	10	7	13
After Incubation ..	40	96	40	54	62	28	34	20	20	27

It is seen that generally the initial nitrate is lower than in the Makanga plots, and the total nitrogen in the control was only 0.08 per cent., compared with an average of 0.15–0.20 per cent. for Makanga soils. The effect of added fertilizer N, particularly as dung, is more clearly apparent after incubation, than from the initial nitrate status. On an adjoining cotton plot, where dung had also been applied the initial nitrate N was 20 p.p.m., and on incubation this increased to 58 p.p.m. The effect of potassic fertilizers was to increase the K in the soil from approximately 1.6 to 2–2.2 m.e. per 100 gm. As usual in the Lower River area, the available phosphate was exceptionally high, 106 p.p.m., with 400 p.p.m. reserves.

Although yields of 12–15 bags as obtained this year would be considered favourable when compared with some areas of Africa, they are lower than obtained elsewhere in Nyasaland. In order to obtain as broad a picture as possible, maize yields at five different stations in this country over the past seven years were plotted. These figures referred to “no fertilizer” control plots. The altitude factor, although not consistent, is quite definite, the general sequence being Chitedze, Tuchila, Chitala, Makanga. Mbawa gives rather erratic results. The response data is less extensive, and rather erratic. Tuchila seems to show more response than Chitedze, and Makanga is less than elsewhere.

The other remaining aspect to consider, is that of micro-nutrients. As a deficiency of most of these would be indicated by visual symptoms in the leaf or cobs, this does not seem to be a likely possibility. The only one that might have an effect on seed setting and hence yield, is copper—but this would appear to be adequately covered by copper fungicides in use. Manganese is also of importance for maize—and would be less available in the Makanga soils than those at Chitedze—but at the same time, visual symptoms would be expected.

OTHER CEREALS

Sorghums

Varieties of sorghum from Port Herald District were planted in small duplicate plots at Tuchila. The three best varieties Masambalabvu, Dembela and Mcirawa-nyumba gave about 2000 lb. grain per acre. These are medium tall varieties with white or grey grain, whose open heads make them fairly resistant to bird damage, which on some varieties was very heavy.

A nitrogen and mulching trial conducted at Makanga gave no significant differences. Both ammonium sulphate and nitrate of soda were used as sources of nitrogen.

TABLE I
Effect of Nitrogen and Mulch on Sorghum yields
Yields : lb. grain/acre

<i>Treatment</i>	<i>Mulch</i>	<i>No Mulch</i>	<i>Mean</i>
Nil	469	423	446
250 lb. per acre S/A	544	389	467
500 lb. per acre S/A	537	287	412
300 lb. per acre N/S	514	420	467
600 lb. per acre N/S	537	454	496
Mean	520	395	457
Coefficient of Variation	10%		

In the past sorghum has been found to give little response to nitrogenous fertilizer at other stations.

Millet

1. BULRUSH MILLET

At Makanga three varieties of bulrush millet were planted on three dates from 17th December to 2nd February, and at three spacings. Only the earliest planting produced a reasonable yield. Different spacings produced no significant differences. 3 ft. ridges were planted with 1 or 2 rows per ridge and with an intra-row spacing of 1 or 2 ft.

TABLE II
Effect of Planting Date and Spacing on yields of Bulrush Millet Varieties
Yields : lb. per acre grain

<i>Variety</i>	<i>Spacing 3 ft. ridges</i>	<i>Time of Planting</i>
Local 926	1 row/2 ft. .. 1,133	17th Dec. .. 1,395
Nigerian 1,700	1 row/1 ft. .. 1,508	9th Jan. .. 154
Nigerian Selection 1,557	2 rows/1 ft. ... 1,549	2nd Feb. .. Nil
Coeff. of Variation. 25%	S E $\pm$ 201	

2. FINGER MILLET

Observation plots at Karonga on time of planting and nitrogen application showed an increase from 1160 lb. per acre of unthreshed heads produced on the control plots, to 1430 lb. per acre of heads where 200 lb. per acre of sulphate of ammonia had been applied—a 270 lb. per acre increase. The late December planting suffered drought and yielded about 270 lb. less than that made in early February. The overall average was just under 1300 lb. per acre of heads.

On eight Instructors' gardens in Rumpi District yields of finger millet drilled on the flat after groundnuts were increased from a mean of 900 lb. per acre of heads to 1340 lb. per acre of heads by the application of 100 lb. per acre of sulphate of ammonia—a 440 lb. per acre increase.

Rice

A replicated experiment was conducted at Baka, Karonga, to test the effects of time of ploughing and time and method of planting. Unfavourable weather and untimely flooding gave very poor yields and a coefficient of variation of 46 per cent. Under these conditions differences of planting time and comparison of early versus late ploughing were not significant. Broadcasting the seed and ploughing it in very significantly increased the yield (1125 lb. per acre paddy) as opposed to surface broadcasting of pregerminated seed (390 lb. per acre paddy) and transplanting seedlings (415 lb. per acre paddy). Broadcasting, particularly when associated with late planting, gave the least weedy plots although the amount of preplanting cultivation was increased. In view of the poor seasonal conditions and the high error of the trial, these results, which are in part at variance with experience and the advice now given to growers, should only be regarded as indicating the necessity of a repetition of the experiment.

Observation plots planted at Mwenitete, Karonga, to assess the effects of nitrogen application showed a large response (1000 to 1200 lb. per acre of paddy) to a 250 lb. per acre dressing of sulphate of ammonia. Control yield was only 970 lb. per acre of paddy. The fertilizer was best broadcast and ploughed in in December, but also gave good results if broadcast before the preplanting cultivation, at the time of planting in January or after the first cultivation in February.

At Mpila Village on the border of Lake Chilwa, rice sown in nurseries in November was transplanted at different dates from the end of December to mid-February into small bunded plots supplied with supplementary irrigation. Early transplanted plots gave 4000–5000 lb. per acre of paddy, while those transplanted between late January and mid-February gave 3000 lb. per acre paddy.

OBSERVATIONS ON IMPLEMENTS FOR RICE CULTIVATION IN KARONGA

During last season, which was wet, the Samson Cultivator proved to be of little use, but this season with its light early rains, showed that under dry conditions the cultivator can give an excellent seed bed and good weed control. Its use is very dependent on weather and it could only be used for a very few days in a season of normal rain.

Spike-toothed harrows likewise must have ideal conditions if they are to cover broadcast seed better than the plough. If these conditions prevail the harrows give a more even germination of seed than the plough, but no increase in yield of paddy.

OIL SEEDS

Groundnuts

1. VARIETY TRIALS

Results of this season's variety trials show that three newcomers compare very favourably with the standard varieties proposed for the various regions. These varieties, Dixie Runner, Early Runner and A.M.2 are late- or medium-late runners having a fairly long dormancy period and fairly large pink-skinned kernels similar to Mwitunde and the majority of the local types. This uniformity is important in marketing for the H.P.S. trade.

TABLE I

Yields of Groundnut Varieties at different stations

Yields: lb./acre shelled nuts. Figures in brackets show order of yield.

Variety	Type	Chitedze	Chitala	Mbawa	Tuchila	Makanga
A.R.S. Spanish	BE	828(8)	1,437(6)	740(8)	1,278(7)	1,003(6)
Gambia	BE	915(7)	1,893(1)	955(7)	1,497(3)	1,536(1)
Mwitunde	BL	1,327(2)	1,483(5)	1,420(1)	1,404(4)	1,014(5)
Early Runner	RM	1,114(4)	1,890(2)	1,100(5)	1,879(1)	1,259(3)
A.M.2	RM	1,039(6)	1,794(3)	955(6)	1,838(2)	1,143(4)
T/A4 Kutambaa	RL	1,294(3)	1,122(7)	1,350(3)	1,096(8)	900(8)
Dixie Runner	RL	1,587(1)	1,662(4)	1,405(2)	1,314(6)	1,351(2)
Chalimbana	RL	1,100(5)	1,122(8)	1,300(4)	1,369(5)	903(7)
Mean		1,150	1,550	1,155	1,459	1,139
L.S.D.		107	211	160	178	178
Coef. of Variation		8.0%	11.6%	11.5%	10.3%	13.0%

B=Bunch E = Early Maturing. 100-110 days—non-dormant.

R=Runner M=Medium Maturing. 125-130 days—dormant.

L = Late Maturing. 140 days—dormant.

It will be noted that at Mbawa and Chitedze all varieties giving yields above average are of the late maturing type. At Chitala, Tuchila and Makanga, at lower elevations, those varieties yielding above average are early or medium early types. Dixie Runner is an exception in that it gives above average yields even at the lower elevations although a late maturing nut. A.R.S. Spanish, a red-skinned Valencia type nut, though giving the best flavoured nuts, is one of the poorest yielders throughout the country owing to its tendency to give a high proportion of shrivelled nuts. Though it is no good for bulk production for the present overseas markets, this variety should not be discarded by those wanting nuts for home consumption. Chalimbana, the extra large sized nut, suffers from a yield below average (except at Mbawa) and an oil content which is also rather low. The variety Kutambaa, which is rather more resistant to *Cercospora* leaf spot than the others, does not appear to profit much from this property. Mani Pintar, a promising new introduction, suffers from a very characteristic skin colouring, red with white flecks, unlike any other variety at present grown.

In the Northern Province at Katobo in the Misuku highlands, bunch varieties did better than the local runner variety, A.R.S. Spanish giving 1300 lb./acre, Gambia 1000 lb./acre and the local only 500 lb./acre. At Baka, on the Karonga Lake-shore, runner types did best, giving 2000 lb./acre unshelled nuts as opposed to 1400 lb./acre from bunch types. Altitude is evidently not the main controlling factor in the Northern Province as to which type of nut will grow best.

2. FERTILIZER TRIALS

Fertilizer trials were conducted at Chitedze and Mbawa to see whether sulphur was a limiting factor in groundnut nutrition. All fertilizers were worked into the ridge before planting.

TABLE II
Effects of Fertilizers on Groundnut yields
Yields: lb./acre shelled nuts

Mbawa (Local Runner)			Chitedze (Mwitunde)		
Treatment	Yield	Resp.	Treatment	Yield	Resp.
Nil	1,610		Nil	1,499	
100 lb./acre S/A	1,600	—10	150 lb./acre S/A	1,358	—141*
Nil	1,593		75 lb./acre Urea	1,338	—161*
50 lb./acre Urea	1,617	+24	75 lb./acre CaSO ₄	1,385	—114*
Nil	1,593		75 lb. Urea + 75 lb. CaSO ₄	1,402	—97*
200 lb./acre Supers	1,617	+24	L.S.D.		91
Nil	1,576		Nil	1,373	
25 lb./acre S. dust	1,634	+58	200 lb. Supers	1,419	+ 46
Mean	1,605		L.S.D. (P=0.05)		140
L.S.D. (P=0.05)		129	Mean	1,396	
Coef. of Variation	10.7%		Coef. of Variation	12.4%	

A significant interaction at Mbawa, showing that a combination of urea and sulphur dust raised yields a little, while each fertilizer alone depressed them, is difficult to explain in view of the negative response to sulphate of ammonia. It does not seem worth while applying fertilizers direct to the groundnut crop.

In the Northern Province it is felt that the production of " Pops " can usually be traced to growing the crop on old brick kilns or housing sites.

3. METHOD OF HARVESTING

At Chitedze, Mwitunde and A.R.S. Spanish groundnuts were again lifted at different times and in different ways to see if it is possible to produce a reasonable hay crop as well as good yields of nuts. The normal method is to windrow the mature crop; this leaves little other than blackened stems as fodder.

TABLE III
Method of Harvesting Groundnuts
Varieties: A.R.S. Spanish and Mwitunde. Yield lb./acre shelled nuts

Treatment	Mwitunde	A.R.S. Spanish
Lift when mature and windrow (standard)	1,123	716
Lift when mature and stook	—	660
Lift early 115 and 75 days respectively—stook	708	377
Cut tops off at 115 and 75 days—lift when mature	597	367
Mean	810	530
L.S.D.	135	92
Coefficient of Variation	9.7%	10.9%

The tops when cut or lifted early and cured carefully to retain the leaf contain 15.5–17.0 per cent. crude protein and 25.5–27.0 per cent. fibre. By stooking the mature plants carefully so as to retain the leaves, one loses only 1.2 per cent. of the crude protein, but samples of trash (consisting largely of the stems of the mature plants) taken from a stripping machine contained only 7.0–8.0 per cent. crude protein and 34.0–35.0 per cent. fibre. The early lifting or cutting of the tops may decrease the yield by half, but if the crop is lifted when just mature and stooked after sunning for a day a fairly good quality hay can be produced.

Bulk Yields

At Chitedze 2 acres of Mwitunde gave 1090 lb./acre, and 4 acres of A.R.S. Spanish 845 lb./acre of shelled seed.

4. TIME OF PLANTING AND LIFTING

At Makanga an early- and late-type groundnut were planted in mid-December and in mid-January and lifted at 10 day intervals from 90–130 days to determine the optimum time of lifting of these nuts in the Lower River. The results are difficult to interpret in that Spanish Bunch normally sprouts after approximately 100 days and yields do not subsequently increase. The trial is being repeated.

TABLE IV
Effects of Dates of Planting and Lifting on Groundnuts at Makanga

Variety: Spanish Bunch and Local Runner. Yields: lb./acre shelled nuts.

<i>Lifted</i>	<i>Variety</i>		<i>Spanish Bunch (early)</i>		<i>Local Runner (late)</i>	
	<i>Planted</i>		<i>16th Dec.</i>	<i>16th Jan.</i>	<i>16th Dec.</i>	<i>16th Jan.</i>
90 days—16/3 or 16/4	..	..	564	432	454	271
100 days—26/3 or 26/4	..	..	689	542*	601*	410*
110 days—5/4 or 6/5	..	..	755*	440	850**	279
120 days—15/4 or 16/5	..	..	770*	454	865**	279
130 days—25/4 or 26/5	..	..	836**	352	1,297***	293
Mean	..	..	723***	444	814***	506
L.S.D. (P=0.05)			Columns ..	128	Mean 81	

At Baka in Karonga, early planted groundnuts gave very much better yields than late planted, especially in the long term runner varieties.

TABLE V
Effect of Time of Planting on Groundnuts at Baka

Variety: Bunch and Runner Varieties. Yields: lb./acre

<i>Time of Planting</i>					<i>Bunch</i>	<i>Runner</i>	<i>Mean</i>
Early planted	..	..	..	..	905	1,200	1,053
Late planted	..	..	..	..	503	110	307
Mean	..	..	..	..	704	655	680

It appears that the growing season for groundnuts was very definitely limited, and whereas the potential yield of the long term runner varieties is higher than that of the short term ones, the latter will make better growth if late planted. These observations need to be confirmed.

In Rumpi demonstration gardens the need for early planting has been most clearly shown.

Extract from Report of the Plant Pathologist

It has not been possible to find a pathogen consistently associated with " Pops ". It is thought that the disease has a physiological cause. (See report of Soil Chemist, Chitedze.)

The two *Cercospora* leaf spots (*C. arachidicola* and *C. personata*) were again widespread. On some soils in Lilongwe District, groundnuts of a lighter green colour, due possibly to a sub-acute deficiency of magnesium, were found to be rather more heavily attacked than groundnuts with the normal dark green foliage.

Rosette incidence was low.

Extract from Report of the Soil Chemist, Chitedze

PLANT ANALYSIS

Work continued in connection with finding the type of groundnut best suited to the local conditions prevailing in different parts of the territory. Eight identical varieties were grown at five research stations situated in the various Provinces and these were then examined for oil content. The results are set out in Table VI.

TABLE VI
Analysis of Groundnut Varieties

Variety	Chitala		Mbawa		Chitedze		Tuchila		Makanga	
	Per cent. Moisture Content of Kernel	Per cent. Oil Content of dry Kernel	Per cent. Moisture Content of Kernel	Per cent. Oil Content of dry Kernel	Per cent. Moisture Content of Kernel	Per cent. Oil Content of dry Kernel	Per cent. Moisture Content of Kernel	Per cent. Oil Content of dry Kernel	Per cent. Moisture Content of Kernel	Per cent. Oil Content of dry Kernel
Spanish Bunch	..	..	..	..	..	..	..	..	..	..
Gambia	5.4	50.1	5.8	50.8	6.0	46.1	6.4	53.6	5.2	49.5
Mwitunde	5.3	50.7	5.8	50.1	5.9	45.9	6.2	54.4	5.0	51.6
Early Runner	..	50.9	5.9	47.7	5.6	49.0	7.5	47.8	5.0	52.1
A.M. 2	5.3	49.4	6.3	47.5	5.8	47.4	7.2	47.9	4.9	52.7
Kutambaa	5.3	50.5	6.6	44.9	5.6	49.2	7.1	48.8	4.7	53.6
Dixie Runner	..	50.8	6.0	49.0	5.3	50.2	7.2	47.6	5.0	51.8
Chalimbana	5.5	51.3	5.7	48.8	5.2	49.1	6.8	49.7	4.9	52.4
	5.8	47.9	6.4	42.6	5.5	45.9	7.5	41.0	5.0	49.1

"POPS" IN GROUNDNUTS

Little or no progress has been made in the past from the examination of soils which have produced healthy and affected plants, but during the past year the plant material has also been examined and preliminary results from this source have been much more encouraging. These are given in Table VII below and show that the affected plants have a much higher K/Ca ratio when compared with the healthy ones. This will now provide a basis for further investigation during the coming season.

TABLE VII
Analysis of Groundnut "Pop" Material

	<i>Lab. No.</i>	<i>Per cent. K</i>	<i>Per cent. Ca</i>	<i>K/Ca Ratio</i>	<i>Lab. No.</i>	<i>Per cent. K</i>	<i>Per cent. Ca</i>	<i>K/Ca ratio</i>
Affected	538a	2.96	1.12	2.64	538c	1.71	.036	47.5
"	543a	2.29	0.76	3.01	543c	2.44	.064	38.1
"	592a	2.00	0.79	2.53	592c	1.90	—	—
"	593a	2.04	0.79	2.58	593c	2.15	.043	50.0
Healthy	594a	2.41	1.28	1.88	594c	1.43	.064	22.3
"	595a	2.18	1.12	1.95	595c	1.33	.064	20.8

Extract from Report of the Agricultural Chemist, Bvumbwe

EXPORT SAMPLES

Thirty-three samples of the 1957 crop were examined. The oil content of the seed as received, varied from 39.3 per cent. to 44.6 per cent. However, when the average for all the consignments to the various buyers were considered, there was a very uniform result. There were three main buyers, the average oil content of the seed supplied to each being as follows:

A 44.6 per cent.; B 44.6 per cent.; C 44.1 per cent.

These figures are standardized to a moisture content of 6 per cent., and testa content of 3.5 per cent.

Examination of 35 samples from the first 48 consignments of the 1958 crop, indicates that generally, the oil content of the seed is about 2 per cent. higher than in the 1957 crop. Average figures for the various buyers are:

A 46.4 per cent.; B 46.7 per cent.; C 46.5 per cent.; D 46.5 per cent.; E 47.2 per cent.

Castor

5. Three varieties, a dwarf early (C 13), a medium-tall late (Commercial) and a giant late (C 5) were planted at different dates during December and January in adjacent and isolated plots. Inflorescence Blight attacked all varieties and all times of planting at all stations, those adjacent to the early planted plots being most heavily attacked.

At Chitedze the dwarf early variety C 13 planted at the beginning of December offers the best hope of a crop being set before the heaviest onslaught of blight in February. This may involve harvesting damp seed and in any case 400-500 lb. per acre seems to be the maximum yield to be expected. A succession of plantings must be avoided.

TABLE VIII

Yields of Castors planted at different times at Chitedze

Variety: see below

Yields: lb./acre seed

Variety	Planted on adjacent plots				Planted in isolated plots			
	9/12	23/12	6/1	20/1	9/12	23/12	6/1	20/1
C13	145	197	91	33	463	259	167	99
Commercial ..	40	18	Nil	Nil	96	94	Nil	Nil
C5	16	Nil	Nil	Nil	75	67	Nil	Nil

At Chitala plantings made on 23rd December, 1957, and 8th January, 1958, grew well but were heavily attacked by the blight and no seed was harvested. A planting on 14th February, 1958, failed to grow. The healthiest plots were those sown in isolation in early January.

At Tuchila mid- and late December sowings all made vigorous growth but Inflorescence Blight was much less severe on later sowings which gave more fruit. It appears that mid- to late January is the most suitable time to sow and C 13, or Commercial, are superior to C 5 in yield.

Extract from Report of the Entomologist

Investigations continue into the insects causing " blindness " of the inflorescence, a *Cecidomyid* (*Contarinia* spp.), has been found which is probably new to science.

Sesame

6. Wild sesame locally collected yielded only about 100 lb./acre seed after making good growth at Chitedze. Growth and yield were best at early December planting, thus:

Planted 9th Dec., 1957, yield 97 lb./acre seed.

Planted 23rd Dec., 1957, yield 64 lb./acre seed.

Planted 23rd Jan., 1958, yield 34 lb./acre seed.

There was considerable loss due to shattering.

At Tuchila the best yield was slightly better but still very disappointing:

Planted mid-December, yield 150 lb./acre seed.

Planted end of December, yield 240 lb./acre seed.

Planted mid-January, yield 90 lb./acre seed.

Planted end of January, yield 50 lb./acre seed.

Planted early February, no yield.

At Chitala the wild sesame yielded nothing and did not even grow, but imported varieties, which had failed at Chitedze, made excellent growth and gave some good yields. Tall-growing late varieties yielded better than medium or dwarf early varieties, the best one (No. 14) giving 700 lb./acre seed and three others giving over 500 lb.

At Baka, Karonga, 500-600 lb. of seed per acre may be expected from sesame planted at 2' x 2' spacing. Sulphate of ammonia depressed yields.

At Makanga, the wild sesame produced yields of about 250 lb./acre seed,

OTHER LEGUMES

Soya Beans

The collection of varieties at Chitedze was sown to renew the seed then two years old. Germination was poor, and pigeon damage heavy. Poor stands were obtained. Fresh seed must be used and planted evenly and not too deeply so that the whole field germinates together, giving the young plants a better chance of growing past the cotyledon stage at which they are most relished by the pigeons. A four acre bulk, part of it a very poor stand, gave 500 lb. per acre of seed.

At Makanga, soya beans were planted on a long term fertilizer trial planted to various crops in rotation. The phosphate treatments were applied to the soya crop, but the nitrogen treatments were residual only from last year's linseed crop.

TABLE I
Effect of Phosphate and Residual Nitrogen on Soya at Makanga

<i>Variety: Commercial</i>						<i>Yield: lb per acre seed</i>
N ₀	Nil	..	..	..	..	1,156
N ₁	100 lb. per acre S/A applied in 56/57 season	..	..	..	..	1,201
N ₂	200 lb. per acre S/A applied in 56/57 season	..	..	..	..	1,301
P ₀	Nil	..	..	..	..	1,210
P ₁	100 lb. per acre Supers applied 24/10/57	..	..	..	..	1,235
P ₂	200 lb. per acre Supers applied 24/10/57	..	..	..	..	1,214
Coefficient of Variation: 15 per cent.						No significant diff.

Extract from Report of the Soil Chemist, Chitedze

The possibility of developing soya beans as a cash crop produced a query regarding the percentage of oil and protein in Nyasaland soya beans. In consequence of this, six varieties grown at Chitedze were analysed and the results are given in Table II.

TABLE II
Analysis of Soya Varieties
100 Per cent. dry matter basis

<i>Variety</i>	<i>Per cent. Oil</i>	<i>Per cent. Crude Protein</i>
Avoyelles	19.50	41.56
B.C.A. Yellow	19.56	41.05
Hernon Local	21.20	39.96
Pelican	21.26	40.48
Potchefstroom	19.88	35.86
Light Speckled	16.25	45.61

Sundry Legume Observations

COWPEAS

Cowpeas at Chitedze were again heavily attacked by *Ascochyta* " Ring Spot " although the seed was dressed with Fernesan and planted on a completely new site, and although the foliage was sprayed with Perenox. The disease is carried within the seed. The varieties Nseula, Tanganyika and Mwazisi yielded about 300 lb. per acre of seed. A bulk area of Turiana yielded nothing.

GROUNDBEANS

The best yielders at Chitedze this year, Northern Rhodesian and Basutoland, gave about 500 lb. seed per acre. No one variety has done consistently well in all three years of bulking and observation to date, but there is now sufficient seed for a small replicated trial.

SUNHEMP

A three acre bulk grown for seed at Chitedze gave 575 lb. per acre seed. Stem break was present in the bulk but not in epidemic proportions as it was on some plots grown as green manure. It does not appear that dressing with Fernesan will completely sterilize heavily infected seed.

ROOT CROPS

Sweet Potatoes

Four varieties of sweet potato were planted at Chitedze on 11th January, 1958, and lifted at monthly intervals between 26th June and 26th August. The time of lifting after six months in the ground made no difference to the yield except that the longer the roots were left in the field, the greater was the damage and theft by animals. The past results of sweet potato variety trials are given below.

TABLE I

Yields of Sweet Potato Varieties at Chitedze

Varieties: as shown

Yields: Short tons/acre tuber.

Variety	Date of planting	8th Feb. 1954	3rd Jan. 1955	9th Jan. 1956	30th Jan. 1956	18th Feb. 1956	2nd Feb. 1957	11th June 1958
	Growing period	6 months	6½ months	6 months	6 months	6 months	5½ months	6-8 months
C ₂ Malamulo ..		2.5*	4.8*	23.0	10.6	4.7	4.7*	4.9
C ₃ Mkokabwato		2.7*	3.6	19.4	14.3	6.0	6.7**	8.4**
C ₇ Kamciputu		1.9	3.6	8.0	9.2	2.8	5.0*	5.3
C ₈ Kacamba ..		1.7	2.7	12.9	14.0	3.8	3.4	10.5***
Mean		2.2	4.2	16.1	12.0	4.3	4.9	7.3
L.S.D. 5%		.8	1.7	—	—	—	.8	2.3
Coefficient of Var. ..		17.8%	32.2%	—	—	—	25.1%	37.1%

Mkokabwato has regularly yielded best and is quite a good keeper and palatable. Malamulo until this year has done well, but the early cessation of the rains has not suited it. Kamciputu is not a very high yielder but it is much favoured for quality. Kacamba until this year has been usually the poorest yielder of the four, but the dry season seems to have suited it.

Cassava

In a demonstration plot at Chikwina, cassava planted on ridges gave a 60 per cent. increase in yield over that planted on the traditional mounds or "matutu".

In the 1954/55 season cassava trials were planted at Chitedze, Tuchila, Kota Kota and Banga to test the yield potential of certain varieties under different climatic conditions and when lifted at different ages. All but one experiment suffered damage through flood or theft and this eliminated the later times of lifting but the following results were obtained.

TABLE II
Cassava Variety and Time of Lifting Trials, 1954-1958
Variety : See below. Yields : Short tons per acre roots.

Variety	Flour	Type	Chitedze		Tuchila	K-K	Banga		
			11 m.	23 m.	20 m.	14 m.	14 m.	19 m.	25 m.
T ₃ ..	Poor	SB	4.2	11.5	13.0	3.3	4.5	11.0	14.3
T ₅ ..	Poor	Bitter	2.6	6.7	10.3	3.7	5.2	7.8	18.8
T ₁₁ ..	Poor	Bitter	—	—	9.0	3.2	8.5	7.4	11.0
T ₁₄ ..	Fair	Sweet	3.7	9.7	23.9	2.6	6.4	8.0	11.4
T ₁₅ ..	Poor	SB	—	—	12.1	1.6	—	—	—
T ₁₈ ..	Good	Sweet	1.4	5.8	14.4	1.3	3.0	4.7	5.8
Chimphuno	Poor	Sweet	4.0	12.6	21.6	—	2.5	7.5	10.3
Kawalika	Good	SB	5.9	15.5	17.5	2.4	13.3	10.6	17.7
Bitisumani	Good	Sweet	5.0	13.3	27.5	2.6	4.3	8.0	9.9
Thipula ..	Good	Bitter	3.8	9.7	9.4	—	5.0	7.5	11.6
Mutheka	Poor	Sweet	5.9	13.7	—	—	3.1	3.8	6.7
Aspin									
Valencia	Good	Sweet	—	4.0	15.3	—	—	—	—
4705A/31	Good	Sweet	—	2.3	11.2	6.4	—	—	—
49139/1 ..	Good	Sweet	—	2.9	—	9.3	—	—	—
Msitu ..	Good	Sweet	—	16.0	—	13.5	—	—	—

Among the original Amani varieties introduced from Tanganyika, T₁₈ is the only one really favoured by those testing the raw roots and the porridge made therefrom, which is excellent. Its "Mosaic" resistance is good but it suffers from being a low yielder. T₁₄ has a yield comparable with the local varieties and has fairly palatable roots, but it is one of the least resistant of the introductions to "Mosaic". The other T varieties have little hope of competing with the local ones unless "Mosaic" becomes much more virulent. They seem to do comparatively best at Kota Kota, but even here they are greatly out-yielded and out-favoured by the later introductions from Tanganyika, which are the last four listed. There is a brighter future for these when they have been more widely tested. Of the local varieties, Kawalika and Bitisumani are probably the best of the sweet varieties for recommendation. Thipula, though a bitter variety, suffered heavily at Chitedze from theft, but it was not established what it was that so relished this variety that it picked these plants out from amongst the rest in three separate replications.

Extract from Report of the Plant Pathologist

EUROPEAN POTATOES

During the course of the year, a survey was made of disease in the potato-growing areas. The main leaf disease, both in main crop potatoes and in potatoes grown in dimba gardens during the winter, is *Alternaria solani* (Ell. & Mart) Sor. All precautions possible are being taken to prevent the entry of Late Blight (*Phytophthora infestans* (Mont) de Bary), from which this country is fortunately still free, but it is thought that the disease will soon invade the potato-growing areas from Portuguese East Africa, where it has recently been reported in a town a few miles from the Nyasaland border.

Bacterial Wilt, caused by *Pseudomonas solanacearum* (E. F. Smith) Dowson, is also widespread in all growing areas.

Actinomyces scabies (Thax) Gussow has been found to occur in occasional dimba gardens.

The commonest virus disease present appears to be the potato leaf roll virus, which is present in all the potato-growing areas.

During the course of the survey some plants were found in a garden adjacent to the Portuguese border suffering from eelworm attack. Laboratory examination of these, however, indicate that they are a species of *Meloidogyne* and not *Heterodera rostochiensis*, as it was originally thought.

TOBACCO

Dark Tobacco

I. VARIETY TRIAL

A selection of the local "Western" strains and four of the best imported varieties (determined from results of previous trials) were compared in an effort to determine if, in fact, the Nyasaland growers were using the best type of dark tobacco available.

TABLE I
Dark Tobacco Variety Trial

Variety	Yield (lb./ acre)	Grade Index	Crop Index	Percentage wrapper leaf
Western: Lingadzi (A.R.S.) ..	592	39.28	23,250	1.70
Type 5 ..	527	41.47	21,837	4.58
Western: Lingadzi (Lingadzi) ..	548	37.09	20,314	1.84
C3-42.AA ..	529	37.49	19,832	3.10
Little Crittenden ..	503	39.41	19,816	3.23
Western: Namitete 54 ..	535	36.64	19,604	3.13
A.R.S. 56 ..	528	35.27	18,626	1.66
Greenwood ..	508	36.34	18,452	2.22
C1-14-A ..	487	37.56	18,274	5.65
A.R.S. 53 ..	448	35.05	15,700	1.83
Madole ..	435	33.84	14,730	0.45
L.S.D. (P=0.05) ..	108	5.71	—	2.18

The Lingadzi Estate selections gave high yields (*see* Table I), but the leaf was long and thin and had the undesirable feature (for a trust land crop) of a "turning in" at the tips. Type 5, of the imported varieties, looked to be the most promising.

Coupled with this experiment was a simple fertilizer trial which clearly showed the value of applying fertilizer to tobacco. The results are given in Table II. Measurements were made on the middle leaf, left after priming and topping, and these demonstrate one of the possible causes of the leaf becoming shorter and narrower, as it is widely held to be by the tobacco trade. It would appear that if the soil is depleted in the main nutrients a reduction in the area of the leaf produced per plant may result. Fertilizer must therefore be applied to give a better quality leaf, having the dimensions favoured by the tobacco trade.

TABLE II
Dark Tobacco Fertilizer Trial

(a) Green Leaf—Middle leaf left at priming and topping

Fertilizer	Length (inches)	Width (inches)	Length-width ratio
No fertilizer ..	20.04	8.30	2.44
200 lb. per acre superphosphate ..	21.83	8.66	2.51
200 lb. per acre sulphate of ammonia ..	24.14	9.97	2.43
200 lb. per acre superphosphate ..	27.05	11.38	2.42
200 lb. per acre sulphate of ammonia } ..			
L.S.D. (P=0.05) ..	1.64	0.95	0.07

(b) Cured leaf

<i>Fertilizer</i>	<i>Yield (lb./ acre)</i>	<i>Grade Index</i>	<i>Crop Index</i>	<i>Percentage wrapper leaf</i>
No fertilizer	395	35.37	13,962	0.35
200 lb. per acre superphosphate	491	29.96	14,705	0.16
200 lb. per acre sulphate of ammonia	767	35.71	27,371	2.33
200 lb. per acre superphosphate } 200 lb. per acre sulphate of ammonia }	1,167	47.85	55,853	7.85
L.S.D. (P=0.05)	286	6.83	—	3.85

2. CULTURAL TRIALS

A series of trials were conducted at Chitedze which attempted to discover if present day topping and priming practice was influencing the size and shape of dark tobacco leaf.

The first trial demonstrated the influence of any type of topping and priming on the size of the eighth node leaf, as measured just prior to harvest. See Table III for results.

TABLE III
Dark Tobacco Topping and Priming Trial

(a) Green Leaf—Eighth Node

<i>Treatment</i>	<i>Length (inches)</i>	<i>Width (inches)</i>	<i>Length-width ratio</i>
1. Prime off three leaves, harvest next ten	27.36	12.20	2.25
2. No priming, harvest ten	27.34	12.54	2.20
3. No priming, harvest first thirteen	26.77	11.50	2.33
4. Prime off six leaves, harvest next seven	28.06	12.67	2.23
L.S.D. (P=0.05)	0.80	0.52	0.06

(b) Cured Leaf

(Fertilizer 200 lb. Sulphate of Ammonia, 225 lb. 'C' Mixture per acre)

<i>Treatment</i>	<i>Yield lb./ acre</i>	<i>Grade Index</i>	<i>Crop Index</i>	<i>Percentage wrapper leaf</i>
1. Prime off three leaves, harvest next ten	1,359	54.28	73,761	17.99
2. No priming, harvest first ten	1,273	50.89	64,801	11.62
3. No priming, harvest first thirteen	1,415	50.66	71,687	13.65
4. Prime off six leaves, harvest seven leaves	1,060	60.67	64,328	20.72
L.S.D. (P=0.05)	96	3.64	—	4.83

The drop in yield which can be expected from reducing the number of leaves harvested from thirteen to seven is not marked, and plants which had been primed gave significantly higher quality leaf with a higher percentage of wrapper leaf than unprimed plants.

In a second trial, bud topping, i.e. the removal of the growing "bud" at thumb-nail size, was compared with the normal practice of removing the flowering shoot when the first flowers have opened. Bud topping was found to have no beneficial effect on the yield or quality of the resultant crop. Since the method was extremely difficult to carry out its value, if any, to the trust land tobacco growers in Nyasaland must be negligible.

The effect of early planting of tobacco on the shape and size of the green leaf, as well as cured leaf yield and quality, was examined in the last of these cultural trials. Time of planting was coupled with a priming experiment intended to show the differences due to removal of either one, two or three leaves at priming.

Green leaf measurements (of the leaf at the eighth node) showed the marked benefit of early planting in the production of a longer and wider leaf as compared to the leaf of late planted tobacco. No differences were found between priming treatments.

TABLE IV
Dark Tobacco Time of Planting and Priming Trial
(a) *Green Leaf—Eighth Node*

<i>Treatment</i>						<i>Length (inches)</i>	<i>Width (inches)</i>	<i>Length-width ratio</i>
(i) <i>Time of Planting</i>								
Early (3-12-57)	..	..	..	..	..	26.20	11.47	2.30
Mid-Season (16-12-57)	..	..	..	..	..	25.70	10.83	2.35
Late (31-12-57)	..	..	..	..	..	23.67	10.10	2.32
(ii) <i>Priming</i>								
Prime off 3 leaves, harvest 10	..	..	..	..	..	24.81	10.69	2.34
Prime off 2 leaves, harvest 10	..	..	..	..	..	25.38	10.71	2.35
Prime off 1 leaf, harvest 10	..	..	..	..	..	25.38	11.00	2.32
L.S.D. (P=0.05)	..	..	..	..	..	1.07	0.52	0.21

(b) *Cured Leaf*
(Fertilizer 200 lb. Sulphate of Ammonia, 225 lb. 'C' Mixture per acre)

<i>Treatment</i>						<i>Yield lb./ acre</i>	<i>Grade Index</i>	<i>Crop Index</i>	<i>Percentage wrapper leaf</i>
(i) <i>Time of planting</i>									
Early (3-12-57)	..	..	..	..	..	1,215	49.95	60,678	9.30
Mid-Season (16-12-57)	..	..	..	..	..	883	35.05	30,971	2.85
Late (30-12-57)	..	..	..	..	..	762	34.77	26,495	0.80
(ii) <i>Priming</i>									
Prime off 3 leaves, harvest 10	..	..	..	..	..	976	43.91	42,831	6.46
Prime off 2 leaves, harvest 10	..	..	..	..	..	956	37.87	36,193	3.94
Prime off 1 leaf, harvest 10	..	..	..	..	..	929	38.00	35,303	2.56
L.S.D. (P=0.05)	..	..	..	..	..	150	5.06	—	4.95

Yield, quality and the percentage of wrapper leaf were significantly improved by early planting. While no increase in yield was noticed between the various priming treatments the results showed the benefit of priming in the production of more high quality leaf.

These experiments show the value of early planting and priming, not only as a method of obtaining a better yield of good leaf, but also as two possible desiderata in the production of the large, broad leaf so desirable to the manufacturers.

3. FERTILIZER TRIALS

(1) 18:9:0 Mixture

Responses to this mixture on tobacco were comparable to the responses of a "home made" mixture of equal nutrient value and to sulphate of ammonia alone. No phosphate deficiency was evident, *see* Table V below.

TABLE V
Dark Tobacco—18:9:0 Fertilizer Trial

<i>Fertilizer</i>		<i>Yield lb./acre</i>	<i>Grade Index</i>	<i>Crop Index</i>
85 lb. per acre sulphate of ammonia	}	1,083	47.29	51,235
50 lb. per acre superphosphate				
100 lb. per acre 18:9:0	..	1,124	44.35	49,846
170 lb. per acre sulphate of ammonia	}	1,173	47.33	55,525
100 lb. per acre superphosphate				
200 lb. per acre 18:9:0	..	1,195	48.26	57,675
170 lb. per acre sulphate of ammonia	..	1,152	49.23	56,737
No fertilizer	..	838	39.11	32,796
L.S.D. (P=0.05)	..	103	5.55	—

(2) *Responses to Phosphate and Potash*

At Tuchila Experiment Station heavy dressings of both phosphate and potash failed to give any significant increase in either yield or quality. The results are given in Table VI below.

TABLE VI
Dark Tobacco—Fertilizer Trial
TUCHILA EXPERIMENT STATION

<i>Fertilizer</i>		<i>Yield lb./acre</i>	<i>Grade Index</i>	<i>Crop Index</i>
(i) <i>Phosphate</i>				
Nil	..	1,096	40.99	44,938
300 lb. per acre superphosphate	..	1,167	41.78	48,758
600 lb. per acre superphosphate	..	1,166	40.54	47,296
(ii) <i>Potash</i>				
Nil	..	1,137	39.55	44,972
75 lb. per acre muriate of potash	..	1,168	41.73	48,767
150 lb. per acre muriate of potash	..	1,124	42.03	47,254
L.S.D. (P=0.05)	..	75	3.42	—

4. LEAF SIZE

Measurements of green leaf were made on many of the trials at the Agricultural Research Station and the results are given below in Table VII.

Seed plants were selected from the bulk crop at Chitedze, and leaf measurements were made on almost two hundred of the most desirable types, from which a final twelve plants were selected. This seed will be bulked up at Toleza next season for subsequent issue to trust land growers. These stock seed plants have the tenth node leaf longer than 30 inches; wider than 14 inches with a length-width ratio of 2.36 or less, and a mid-rib circumference of 2 inches or less.

Examination of samples of leaf from trust land tobacco, taken at the Lilongwe grading centre in the 1957 season, showed that no difference existed between samples taken early in the season and those taken towards the end of the season. It appears that the percentage of usable leaf (laminar tissue)—the main interest of manufacturers—is distinctly higher in broader leaf than in narrow leaf of the same grade.

TABLE VII
Dark Tobacco Trust Land Crop—Leaf Size

				Grade 3 heavy wrapper 23" and over	Grade 5 heavy wrapper 19 to 23"	Grade 11 wrapper 16 to 19"
(a)	<i>Length (inches)</i>					
	Range of length	..	..	22 to 31	20 to 25	17 to 21
	Average length	..	..	25.507	22.669	18.862
	Standard deviation	..	..	±1.575	±0.773	±0.761
(b)	<i>Width</i>					
	Range of width	..	..	5 to 10	5 to 11	4 to 9
	Average width	..	..	7.069	6.790	5.916
	Standard deviation	..	..	±1.110	±1.062	±0.909
(c)	<i>Length-Width Ratio</i>					
	Range of ratio	..	..	2.31 to 5.51	2.11 to 4.51	1.91 to 4.71
	Average ratio	..	..	3.62	3.36	3.20
	Standard deviation	..	..	±0.53	±0.52	±0.48
(d)	<i>Percentage Usable Leaf</i>					
	Width 5 and 6 inches	..	..	74.71%	76.61%	75.79%
	Width 7 and 8 inches	..	..	76.02%	77.04%	77.23%
	Width 9 and 10 inches	..	..	78.00%	78.82%	80.00%

Burley Tobacco

I. VARIETY TRIAL

Nyasaland burley tobacco growers require a high yielding variety which gives a good quality leaf having a reasonable percentage of "coloury" (light cinnamon) cigarette type leaf. As American and Canadian varieties of burley are considered to produce large amounts of this light leaf, six of their best varieties were imported directly from the Harrow Experimental Station, Ontario, and their performance was compared with that of six of the established varieties of Nyasaland. The results are given in Table VIII below.

TABLE VIII
Burley Tobacco—Variety Trial

Variety	Yield lb./ acre	Grade Index	Crop Index	Percentage Coloury Grades	Percentage Red Grades
Barnet Special	1,784	53.32	95,099	43.76	21.32
Green Briar	1,602	55.62	89,109	44.62	20.67
Stand Upright	1,595	52.86	84,320	44.21	24.16
Kentucky 16	1,709	48.94	83,639	35.19	21.93
*Burley 1	1,671	48.78	81,500	38.57	19.00
*Burley 21	1,707	47.05	80,324	42.56	17.49
*Virginia 29	1,687	45.39	76,563	37.56	16.75
*Harrow Velvet	1,626	46.47	75,539	40.76	20.03
Gay's Yellow	1,492	50.62	75,520	36.07	23.97
Kentucky 19	1,744	42.80	74,634	33.23	15.51
*Burley 2	1,548	46.81	72,447	40.40	15.26
*Haronic	1,595	40.31	64,307	24.93	17.05
L.S.D. (P=0.05)	145	4.05	—	6.15	4.49

(Fertilizer, 200 lb. Sulphate of Ammonia, 200 lb. "C" Mixture per acre)

* Variety imported from Canada 1957.

These results show that, as regards yield, of the Nyasaland varieties Gay's Yellow alone gave less per acre than the imported types; Kentucky 19 did not compare favourably with the imported types in leaf quality. There was little difference

between varieties in the proportion of "coloury" leaf produced; the highest percentage of coloury leaf was in the three "local" varieties, Barnet Special, Stand Upright and Green Briar. The difference between the total percentage and that of red plus coloury is due to low grade leaf which in commercial grading is not divided into red and coloury types. Chemical analysis has now shown this low grade burley to have a composition comparable to that of a "coloury" leaf. Assuming this, the percentage of "red" leaf becomes more important in comparison of varieties; the local "Stand Upright" has the highest percentage of red grades; the imported varieties have, generally, a lower amount of red leaf than the Nyasaland types.

2. COLOURY TRIAL

The object of this trial was to make a preliminary study of the possible factors influencing the production of "coloury" leaf. Comparison was made between the varieties "Stand Upright" and "Barnet Special". These were spaced at 18 inches or 24 inches within the row and sulphate of ammonia was applied at two rates. Basic dressings of phosphate and potash were also given. The plants were then topped either at the first sign of the bud (bud topping) or when the flowering shoot was elongated and the flowers open (late topping). In addition, high topping, removing of the shoot plus two leaves, was compared with low topping, removing the shoot plus five leaves. Results are given in Table IX.

It will be seen that the variety Barnet Special gave a higher yield of coloury leaf and a lower yield of red leaf than did Stand Upright. Bud topping significantly increased only the amounts of coloury leaf produced and not the total yield per acre. High topping significantly increased the total yield, whilst low topping gave a higher amount of red leaf per acre. Close spacing (3'×18") resulted in improved yields without any effect on the relative percentages of red and coloury leaf. The use of 300 lb. per acre sulphate of ammonia gave improved yields but increased markedly the percentage of red leaf. (See Agricultural Chemist's Report, page 47, for chemical analysis of leaf from this experiment.)

In considering these results two factors are of great importance. Firstly, coloury leaf commands a slightly higher price than does red leaf. Secondly, a treatment with a high percentage of coloury leaf, but with a low yield, is less profitable financially than a proportionally higher yielding treatment with a slightly lower percentage of coloury leaf.

TABLE IX
Burley Tobacco—Coloury Trial

<i>Treatment</i>	<i>Total yield lb./acre</i>	<i>Percentage Coloury Grades</i>	<i>Yield Coloury lb./acre</i>	<i>Percentage Red Grades</i>	<i>Yield Red lb./acre</i>	<i>Crop Index</i>
Stand Upright	1,219	47.2	575	19.2	234	57,328
Barnet Special	1,314	43.9	577	15.1	198	57,416
High topping	1,314	45.1	593	15.7	206	57,768
Low topping	1,218	46.0	560	18.5	225	56,997
Bud topping	1,268	47.5	602	16.8	213	58,071
Late topping	1,265	43.6	552	17.4	220	56,831
36"×18" Spacing	1,438	45.2	650	16.9	243	65,028
36"×24" Spacing	1,095	45.9	503	17.3	189	49,824
150 lb. sulphate of ammonia per acre	1,071	44.7	479	14.5	155	44,817
300 lb. sulphate of ammonia per acre	1,461	46.4	678	19.7	288	71,464
L.S.D. (P=0.05)	733	2.4	—	1.5	—	—

Turkish Tobacco

Trials both at Mbawa Experiment Station and at the Agricultural Research Station have shown the value of planting early and applying potash, in increasing yield. No responses to nitrogen (either nitrate of soda or sulphate of ammonia) or phosphate were evident. Results, given in Table X, only show how such treatments influence yield and not the quality of the leaf so produced.

TABLE X
Turkish Tobacco—Fertilizer and Time of Planting Trial

<i>Treatment</i>	<i>Agricultural Research Station yield lb./acre</i>	<i>Mbawa, Experiment Station yield lb./acre</i>
(i) <i>Nitrogen</i>		
19 lb. nitrate of soda per acre ..	513	924
Nil	519	927
(ii) <i>Nitrogen</i>		
15 lb. sulphate of ammonia per acre	515	943
Nil	516	909
(iii) <i>Phosphate</i>		
150 lb. superphosphate per acre ..	528	936
Nil	504	916
(iv) <i>Potash</i>		
75 lb. muriate of potash	549	963
Nil	482	889
(v) <i>Time of Planting</i>		
Early	650	1,001
Late	381	851
L.S.D. ($P=0.05$)	26	44

Extract from Report of the Plant Pathologist

DARK-FIRED WESTERN

Scab, caused by *Septomyxa affinis* (Sherb) Wollenw., was serious on seed beds in the Central Province. The crop in the field suffered attack by *Cercospora nicotianae* Ell. and Ev., though nowhere was it epidemic. *Alternaria longipes* (Ell. and Ev.) Mason also occurred, as did "Red Rust", a physiological leaf spotting which it is possible, in some circumstances, to confuse with *Alternaria* leaf spots.

BURLEY

Heavy attacks by *Cercospora nicotianae* Ell. and Ev. occurred during the year. One new record of some interest on this crop in the Lilongwe District was *Fusarium oxysporum* causing a one-sided wilt of plants.

TURKISH

This tobacco crop appears to be particularly susceptible to the organism causing scab, *Septomyxa affinis* (Sherb) Wollenw.

Leaf curl virus caused some damage on a Turkish seed crop in the Southern Province. }

FLUE-CURED

The season got off to a bad start, as reported last year, with the advent of anthracnose (*Colletotrichum tabacum* Böning). This was followed by very unfavourable weather conditions, a late start to the rains causing the death of much of the dry-planted tobacco. Following this, continuous rain in December, January and February caused a uniformly low flowering height, and created suitable conditions for development of leaf spotting organisms, *Cercospora nicotianae* Ell. and Ev. in particular reaching epidemic proportions. 21

Alternaria longipes (Ell. and Ev.) Mason was again widespread, and assumed epidemic proportions on one estate in Kasungu District.

In the course of the year, a scheme was devised to attempt to prevent the spread of *Colletotrichum tabacum* Böning from those twelve estates on which it was recorded last year. This scheme demanded the use of an approved fungicide or fumigant as a pre-sowing soil treatment on seed beds, and subsequent spraying of the seedlings arising from these seed beds with an approved fungicide. It is too early as yet to comment on the success or otherwise of this scheme.

One of the fungicides it was decided to recommend as a pre-treatment was Thiram, in spite of reports of phytotoxicity from elsewhere (Riley, *E.A. Trop. Agric.* Vol. 32, p. 201 and Cole, J. S., *Ann. App. Biol.* Vol. 45, p. 542). In order to test the margin of safety allowed by this fungicide, a trial, necessarily small owing to limitations of space, was laid out on a medium brown sandy clay loam. Three levels of Thiram (80 per cent.) were used, 1 oz./30 sq. yds., 1½ oz./30 sq. yds. and 2 oz./30 sq. yds. The seed beds were prepared according to standard practice in this country, brush wood being burnt on them in order to effect some sterilization, and then the Thiram watered on at the appropriate rates, using an amount of water equivalent to four gallons/30 sq. yds. A simple random block layout was used with three replicates. The beds were sown at the recommended rate of 1 oz./400 sq. yds., and were mulched, using grass cut into approximately 9 in. lengths, following recommendations of the Tobacco Research Board of Rhodesia and Nyasaland. The beds were sampled using a 6 in. square quadrat at datum points taken at regular intervals from 1 point selected at random in the first 30 ins. of the bed, running down the middle.

The results are presented below, and show that though the number of seedlings emerged was reduced considerably by even the lowest application of Thiram, this was, in actual fact, an advantage, as the number of seedlings/sq. foot then approximates more closely to the ideal suggested by the Tobacco Research Board, i.e. 65-70 seedlings/sq. foot. The total dry weight of seedlings was increased by the lowest application of Thiram, though increasing concentrations of Thiram resulted in a decrease in dry weights. It was decided to include the shoot/root ratio as previous reports indicate that one of the effects of pre-treating soil with Thiram was stunting of the root system. Though a slight increase in the ratio is recorded with the use of Thiram, this is not significant.

Treatments

0=control

1=Thiram at 1 oz/30 sq. yds.

2= „ at 1½ oz/30 „ „

3= „ at 2 oz/30 „ „

TABLE XI
Numbers of Seedlings

Blocks	Treatments				
	0	1	2	3	Total
A	264	231	187	230	912
B	152	114	212	125	603
C	272	188	166	162	788
Total	688	533	565	517	2,303
Average	229.3	177.6	188.3	172.3	—

L.S.D. ($P=0.05$) = 84.1
Mean 191.9
Standard deviation = 51.1

TABLE XII
Total dry weight—gm/100 Seedlings

Blocks	Treatments				
	0	1	2	3	Total
A	3.78	3.06	3.93	3.26	14.03
B	4.14	7.20	3.33	4.67	19.34
C	8.00	8.44	11.19	9.35	36.98
Total	15.92	18.70	18.45	17.28	70.35
Average	5.307	6.233	6.150	5.760	—

L.S.D. ($P=0.05$) = 3.206
Mean = 5.86 gm
Standard deviation = 2.81

TABLE XIII
Shoot/root ratio

Blocks	Treatments				
	0	1	2	3	Total
A	8.34	8.08	9.49	9.27	35.18
B	8.13	8.89	8.29	10.00	35.31
C	9.16	11.20	10.12	9.74	40.22
Total	25.63	28.17	27.90	29.01	110.71
Average	8.543	9.390	9.30	9.670	—

L.S.D. ($P=0.05$) = 1.681
Mean = 9.22
Standard deviation = 0.95

Extract from Report of the Entomologist

I. " UNIFUME " EXPERIMENT ON TOBACCO SEEDBEDS

A simple experiment was carried out to test the effectiveness of sodium n-methyl dithiocarbamate against Tobacco Root Knot Eelworm (*Meloidogyne javanica*), under Nyasaland conditions. It is especially suitable for use by Africans growing tobacco, by virtue of the ease with which it can be applied, i.e. with a watering can. The seed bed site chosen was known to be well infested with eelworm. The experiment had 2 treatments, Unifume and no Unifume; there were 3 blocks. The treatment was carried out exactly according to the maker's instructions at a rate of 2 pints Unifume to 100 square feet of seed bed and the maximum recommended period (25 days) allowed to elapse before seed beds were sown with "Western Dark-Fired" tobacco seed.

Sixteen days after sowing, germination counts were carried out to see whether the treatment had any deleterious effect on germination. The results are given in Table XIV, from which it will be seen that the treatment had no adverse effect and gave almost complete control of weeds.

TABLE XIV
Germination Counts

(3" × 3" Quadrats. 6 Counts per plot)

Block No.	Treated		Untreated	
	Tobacco	Weeds	Tobacco	Weeds
I	47	1	39	24
II	29	Nil	43	26
III	58	2	42	27
Total	134	3	124	77

One month after sowing, 6 soil core samples (5 cm. in diameter and 8 cm. in depth) were taken from each plot and the soil carefully washed from the tobacco seedling roots. The roots were then sub-sampled and 50 1-inch lengths taken from the root mass, these lengths were examined under the binocular microscope for lesions caused by eelworm attack. Table XV gives the results of these determinations and shows that almost complete control had been obtained of eelworm at this stage. Table XVI shows the position a fortnight later at the time of transplanting the seedlings. In this case the root lengths examined were obtained from a sub-sample of 5 plants from plants pulled for transplanting. It will be seen that at this stage control is still practically complete.

TABLE XV
Eelworm Lesions

Block Totals for 6 cores (50 × 1" root lengths per sample core)

Block No.	Treated	Untreated
I	4	37
II	Nil	88
III	Nil	20
Total	4	145

TABLE XVI

Block Totals. Lesions recorded at the time of transplanting
(5 plants per plot at random. 50 × 1" root lengths per sample)

Block No.	Treated	Untreated
I	2	427
II	Nil	111
III	1	111
Total	3	649

A small number of the seedlings from each plot were planted out on land thought to be reasonably free from Root Knot Eelworm. It was noticeable that those plants which came from treated beds grew more evenly and did not require so much "supplying" as those from untreated beds. When these tobacco plants were uprooted at the end of June the root systems were scored for the degree of galling caused by eelworm. Table XVII below shows the results.

TABLE XVII

Degree of Galling on Roots at uprooting

Block No.	Treated			Untreated		
	Clean	Slight	Heavy	Clean	Slight	Heavy
I	19	14	5	Nil	9	28
II	9	16	16	1	9	29
III	11	15	19	12	13	21
Total	39	45	40	13	31	78

It will be seen that although two-thirds of the plants from the treated beds became infected when planted out in the slightly infected field soil, only half of these actually developed severe galling, a much better position than that with the seedlings from the infected beds. The hypothesis is advanced that even when seedlings are planted out in slightly infected fields, it is still well worth while to fumigate the seedbeds. The fact that the seedlings have been raised eelworm free gives them a better start, a more sturdy root system and a partial ability to withstand subsequent eelworm attacks in the field.

2. OTHER ENTOMOLOGICAL OBSERVATIONS ON TOBACCO

A severe attack of tobacco budworm (*Plusia acuta* Walk.) on burley tobacco occurred in the Lilongwe District of Central Province in January, 1958. The insect confined its attentions to the growing point of the plant and in severe cases completely destroyed the growing point. Many plants, attacked early on in their development, were able to grow away from the attack because only the bottom leaves were badly damaged. Where plants were attacked late in their development only the upper leaves (removed at topping) were damaged and so the attack was of no consequence. In fields where the attack was serious the pest was controlled by treatment with 10 per cent. DDT at a rate of 10 lb. per acre, applied as a "pinch" to the growing point of each plant.

Extract from Report of the Agricultural Chemist, Chitedze

TOBACCO LEAF ANALYSIS

(a) COLOURY AND RED BURLEY

The tobacco trade require lighter coloury leaf in preference to heavier red, and ways and means are being studied to increase the production of this type of leaf. Experimental work at Chitedze has already shown that increasing the application of fertilizer nitrogen decreased the percentage of coloury leaf produced. It was thought that this effect and other factors might be reflected in the chemical composition of the two types of leaf, and that the results would possibly give a lead as to other practical measures that could be taken to increase the percentage coloury leaf. The preliminary results of this investigation have proved to be interesting and are given in Tables XVIII and XIX.

TABLE XVIII
Cured Burley Leaf (Red and Coloury Grades)
(100 per cent. dry matter basis)
Variety: Stand Upright

Lab. No.	Grade	Moisture	Total Ash	Nicotine	Crude Fibre	Ether Extract	Per cent. N	Per cent. P_2O_5	Per cent. K_2O	Per cent. Cl
564 ..	1C	9.6	21.03	2.22	14.03	6.17	3.10	0.83	7.29	0.37
565 ..	1R	9.4	19.65	3.27	12.47	5.38	3.34	0.68	6.18	0.55
566 ..	2C	9.2	20.31	2.41	14.47	5.91	2.58	0.95	6.48	0.32
567 ..	2R	9.6	18.27	3.65	13.66	5.11	3.27	0.73	5.98	0.62
568 ..	3C	9.0	20.49	1.64	14.58	6.29	2.85	0.87	7.31	0.35
569 ..	3R	8.4	18.10	3.44	12.61	5.04	3.54	0.79	5.79	0.61
570 ..	6	7.8	22.83	1.08	14.30	5.85	2.42	0.80	7.64	0.41

C=Coloury R=Red 6=Low Grade Burley.

TABLE XIX
Cured Burley Leaf (Red and Coloury)
(100 per cent. dry matter basis)

Var. Barnet Special

Var. Green Briar

Lab. No.	Grade	Total Ash	Nicotine	Per cent. N	Per cent. K_2O	Lab. No.	Grade	Total Ash	Nicotine	Per cent. N	Per cent. K_2O
571 ..	1C	21.90	2.30	2.81	7.57	578	1C	22.19	2.78	3.09	8.14
572 ..	1R	19.51	2.80	3.44	6.55	579	1R	20.28	4.36	3.60	6.87
573 ..	2C	20.67	2.13	2.78	7.19	580	2C	21.11	2.30	2.89	7.38
574 ..	2R	19.18	3.00	3.19	6.54	581	2R	18.89	3.95	3.38	6.54
575 ..	3C	18.28	1.87	2.86	5.49	582	3C	20.70	2.32	2.63	7.21
576 ..	3R	18.08	2.45	3.55	6.19	583	3R	17.10	3.65	3.38	6.09
577 ..	6	23.53	1.50	2.90	9.02	584	6	24.40	1.99	2.77	9.08

C=Coloury R=Red 6=Low Grade Burley.

(b) BURLEY VARIETIES

In Table XX below, figures are given for the chemical composition of twelve varieties of burley. Of these the first six represent those which have yielded consistently well over some years in the variety trials at Chitedze, while the remaining varieties are the most promising ones received from the research station at Harrow in Canada. The type of leaf most popular with the buyers is apparently that with a low nitrogen and nicotine content. On this basis the relative merits of the various varieties may be compared.

TABLE XX
Cured Burley Leaf Varieties—One Grade
(100 per cent. dry matter basis)

Lab. No.	Variety	Moisture	Total Ash	Nicotine	Per cent. N	Per cent. P ₂ O ₅	Per cent. K ₂ O	Per cent. Cl	Per cent. S
552 ..	Stand Upright	11.4	20.11	2.66	3.40	0.81	7.28	0.35	0.34
553 ..	Barnet Special	11.8	21.49	2.35	3.69	0.93	7.77	0.37	0.37
554 ..	Gay's Yellow	13.2	20.44	3.05	3.81	0.79	7.32	0.22	0.34
555 ..	Green Briar	12.4	21.66	2.83	3.32	1.00	7.80	0.37	0.42
556 ..	Kentucky 16	10.8	21.52	2.12	2.62	0.83	7.83	0.34	0.43
557 ..	Kentucky 19	10.8	21.33	2.08	2.93	1.03	6.76	0.28	0.44
558 ..	Burley 1	11.6	21.08	1.53	2.50	0.86	7.07	0.23	0.32
559 ..	Burley 2	10.8	19.33	2.39	3.20	0.48	7.21	0.47	0.36
560 ..	Burley 21	10.0	20.17	2.00	3.08	0.78	6.83	0.32	0.34
561 ..	Haronic	9.6	20.25	1.98	2.47	0.80	7.30	0.35	0.38
562 ..	Harrow Velvet	10.4	20.09	2.51	3.19	0.76	6.73	0.63	0.36
563 ..	Virginia 29	10.4	19.75	2.36	3.14	0.70	7.42	0.40	0.45

All plants received 200 lb./acre S/A+200 lb./acre Superphosphate.

(c) DARK FIRE-CURED TOBACCO GRADES

In this type of tobacco the main requirement is for bodied leaf, which corresponds to that found in the wrapper rather than the filler grades. Examination of the chemical composition of the leaf of several of these grades was carried out from which it may be noted that the wrapper grades were found to have a higher nitrogen and nicotine content than those of the filler. The results are set out in Table XXI.

TABLE XXI
Dark Fire-Cured Leaf—Wrapper and Filler Grades
(100 per cent. dry matter basis)

Lab. No.	Grade	Length	Total Ash	Nicotine	Per cent. N	Per cent. P ₂ O ₅	Per cent. K ₂ O
653 ..	B—Heavy Wrapper	23" and over	18.14	5.34	3.66	0.51	4.94
654 ..	C—Light Filler	23" and over	18.87	4.87	3.34	0.62	5.78
655 ..	D—Heavy Wrapper	19–23 in.	17.18	4.83	3.53	0.63	4.96
656 ..	D—Light Wrapper	19–23 in.	17.91	5.22	3.75	0.84	5.39
657 ..	E ₂ —Heavy Filler	19–21 in.	18.21	4.83	3.34	0.58	4.38
658 ..	E ₂ —Light Filler	19–21 in.	19.15	4.12	2.97	0.41	4.02
659 ..	F ₁ —Wrapper	16–19 in.	16.46	5.45	3.41	0.55	4.48
660 ..	F ₂ —Filler	16–19 in.	19.28	4.48	3.15	0.80	4.78

Extract from Report of the Agricultural Chemist, Bvumbwe

TOBACCO (DARK FIRED)

Leaf from the plots of the fertilizer experiment at Tuchila (*see* Table VI, page 39) were analysed to see if there was any relation between change in composition and quality. The experiment was carried out on a sandy loam top soil overlying sandy clay loam. The potash content was high (1.2 m.g.e./100 gm.), and the available phosphate was just satisfactory (28 p.p.m. by NH₄F extract) the reserves being 70 p.p.m. The total nitrogen was 0.13 per cent. The levels of P and K were provided by 300 and 600 lb. supers, and 75 and 150 lb. of muriate of potash.

The results are summarized below in Table XXII.

TABLE XXII

Grade B

Treatment			Wt. of leaf (gm.)	Ash per cent.	N per cent.	P per cent.	K per cent.	Ca per cent.	Mg per cent.
Control	..	..	14.5	16.7	3.74	.28	3.28	2.37	.72
P ₂	..	..	15	17.1	3.43	.32	3.51	2.36	.73
K ₂	..	..	16.5	17.1	3.73	.33	3.33	2.54	.80
P ₂ K ₂	..	..	14	16.9	3.50	.36	3.95	2.22	.72

Grade E

Control	..	..	10.5	16.6	3.38	.34	3.49	2.52	.75
P ₂	..	..	11	17.3	3.20	.37	3.42	2.26	.64
K ₂	..	..	12	16.6	3.44	.36	3.38	2.67	.82
P ₂ K ₂	..	..	12	18.0	3.42	.39	3.93	2.60	.75

The B leaf is heavier and contains more nitrogen than the E grades throughout the experiment. There appears no marked variation of N, with the PK treatments.

The P and K treatments separately do not appreciably affect the corresponding levels of these elements in the leaf, but when combined in the P₂K₂ treatment there is a marked increase in both the P and K contents. However this changed composition was not sufficient to affect either the yield or quality index of the crop.

TOBACCO (FLUE-CURED)

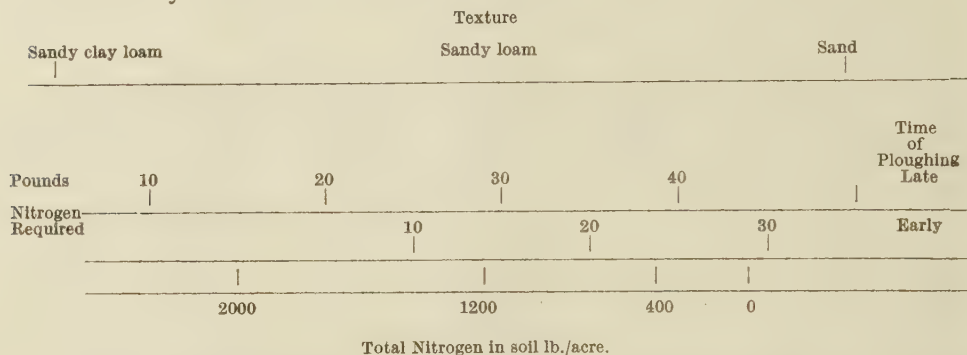
I. FERTILIZER RECOMMENDATIONS

The survey of tobacco soils detailed in last year's report has formed the basis of recommendations during this season.

The main classification of soils has therefore been made according to their content of nitrogen. Although all the soils would be considered low in nitrogen for most crops, the following minor differences can be noted as important for tobacco: Low—1000 lb./acre or less; Medium—1200–1600 lb./acre, High—more than 1600 lb./acre. Determinations of mineralizable nitrogen has given more information—but from figures so far obtained, they only emphasize the higher nitrogen status of Nyasaland soils compared to those of Southern Rhodesia. It therefore appears that the best nitrogen control will be exercised by soil-management, i.e., by late ploughing of the heavier soils. To assess the amount of fertilizer nitrogen to be applied—both top and lower soils should be considered. For example, if a high amount of nitrogen is applied on a sandy top soil in accordance with recommendations, and the underlying soil is heavier, then this high amount of nitrogen will be held within the root zone, and may be detrimental. It is therefore advisable to reduce the nitrogen on such soils to a level between that required by the top and sub-soil.

The recommendations made by the Tobacco Research Board must therefore be considered against the nitrogen status of the soils on which their experiments were carried out. Such data was therefore obtained, and considered with the data on Nyasaland soils. The two factors of initial nitrogen content and texture, can then

be related as shown in the nomogram below. This gives a rapid method of indicating nitrogen requirements—but allowance should also be made for any outstanding cultural history.



Nitrifiable nitrogen has also been determined on all soils submitted during the year. From such figures, the fertilizer requirements have also been assessed, on the basis of similar data for Southern Rhodesian soils. For the lighter soils, there appears fair agreement between the nitrogen estimated from both total and nitrifiable nitrogen. On the heavier soils or where the total nitrogen is higher, the nitrifiable nitrogen would classify the soil as unsuitable for flue-cured tobacco. The fertilizer nitrogen assessed from total nitrogen in the soil then appears more practicable but it is clear that the limits for Nyasaland soils will differ from those of Rhodesia, and that experience will define these more closely.

As mentioned last year, the problem of P and K levels will take time to resolve but there is some evidence to indicate that where the recommended amounts of potash and phosphate (90 and 100 lb.) are applied, it does tend to act as a buffer to any adverse effects arising from any minor error in the assessment of nitrogen needs.

During the period under review, 405 soil samples were examined from 48 estates.

2. SOIL SURVEY FOR DEMONSTRATION FARM

In connection with the proposed Tobacco Demonstration Farm, an area of approximately 900 acres was surveyed at an estate near Ntondwe, and 40 samples taken for laboratory examination. This again revealed the pattern of red deep loams in one area with more gravelly soils in the eastern and southern sections. Generally the soils are structurally and texturally preferable to those in the area nearer Limbe examined earlier in the year, and the topography and drainage also appear better. The general nutrient status is in the low to medium range, P being rather high. Subsequently a further estate in the Magomero area was similarly surveyed. This was larger, and although one half was rocky and unsuitable, the remainder contained typical loamy soils.

3. NUTRIENT STUDIES

(a) Irregular growth of tobacco seedlings in a Magomero nursery suspected as being due to salinity appeared to be caused by irregular drainage conditions, the smaller plants being near a drainage line and underlain by heavier and less gravelly soils.

(b) Although the exceptional climatic conditions must be considered, there appeared less barn shatter this year, and generally, better nitrogen control seems to have given more uniform and improved quality, in fact the nitrogen in some instances may have been on the low side. The slightly lower yields would appear however to be balanced by a higher proportion of good leaf.

An instance of a high proportion of shatter was examined on one estate. Representative leaf was examined but the nitrogen factor did not appear to be the predominant cause, that of the sample of satisfactory leaf being 2.09 per cent., and in the shattered leaf 2.25 per cent. Although it was of some significance that leaf from the heavy part of the field contained 2.4 per cent. N, and that from the sandy soil 1.9 per cent.

In a sample of leaf from a field of low K status, when the full TRB recommendation for K had not been applied, the K content was found to be 3.6 per cent., not greatly different from previous figures.

(c) FERTILIZER EXPERIMENTS. Although two sites covering lighter and heavy soils were selected for fertilizer experiments, only one was carried through. This was in the Cholo area, and the profile consisted of 4" of loamy sand top soil, loose and friable and which appears to be limit of continued cultivation. Below this there is a sharp increase in clay content to 31 per cent. as reflected in the "blocky" structure. The clay content again rises to 40 per cent. in the 12" 18" horizon, remaining constant to 24". At 3' the soil contains less clay, and a higher proportion of biotitic fine sand as the decomposing parent material is approached. Cracking is not apparent at depth but this may be due to moisture, as sun dried faces had cracked to some extent. A vein of broken quartz cuts diagonally across the profile occurring at depths of from 15" to 36". Immediately below this vein there is some increase in clay content. The colour changes from grey brown through brown to yellow brown at depth, and in the lower horizons mottling is apparent. The blocky structure is massive being 1' square.

In nutrient status the P and K were high, the phosphate being about 200 p.p.m. available and 1500 p.p.m. reserves. The potash content was 1 m.g.e./per 100 gm. The nitrogen was in the medium range, 0.08 per cent., although this is high by Rhodesian standards.

Although valuable information was found on nitrogen requirements, and the importance of good tilth and soil preparation, no indications were obtained as to the optimum amounts of phosphate and potash. To assist in this, 26 representative leaf samples from the various plots were analysed. Their composition, tabulated according to treatments, is given in Table XXIII below.

TABLE XXIII

N			Treatment			Composition (per cent. on dry wt.)					
			Ploughed	PK	Leaf wt. (gm.)	N	P	K	Ca	Mg	Ac%
0	..	..	Early	low	4.8	1.69	.45	3.48	2.20	.46	17.1
0	..	..	Late	"	3.1	1.83	.45	3.74	2.05	.39	19.2
10	..	..	"	"	4.2	1.85	.56	4.29	1.62	.40	14.0
10	..	..	"	high	3.8	1.90	.57	3.68	1.75	.42	14.0
20	..	..	"	"	4.8	1.96	.57	3.78	1.62	.47	14.4
30	..	..	Early	"	7.2	1.74	.35	3.27	1.75	.37	13.4
30	..	..	Late	low	6.0	1.51	.40	4.09	1.71	.37	13.2
30	..	..	"	high	6.6	1.89	.41	4.53	2.26	.38	14.1
40	..	..	Early	"	9.0	1.47	.34	3.73	1.97	.32	15.0
40	..	..	Late	low	7.0	1.74	.40	3.37	2.18	.31	13.7
40	..	..	"	high	6.9	1.80	.37	3.99	2.01	.39	13.4

The low and high applications of phosphate and potash were 80 and 60 lb., and 160, 120 lb. respectively. From the composition of the leaf, there is little to be discerned, but the higher applications of nitrogen give a larger leaf, with little

variation in nitrogen content. For the same application of nitrogen a heavier leaf is obtained from the early ploughed soils. The dressings of P and K do not appear to alter the content of phosphate, although in some instances at the higher levels of N, the higher K applications do give a slightly higher K content in the leaf. The K content of leaf from early ploughed soils is lower in some instances, than is that of leaf from late ploughed land. This would suggest that where the heavier leaf is obtained, there is a possibility that K supplies may be rather extended, although no indications of this were given from the quality gradings. This fact, however, may afford some explanation of field observations made, i.e. that any adverse effect of small amounts of excess nitrogen has been reduced by adequate P and K fertilizers.

4. MINERAL CONTENT OF TOBACCO LEAF

The reference in last year's report to the adverse effect of rather saline borehole water on nursery beds, led to the suggestion that this might affect the final composition of the leaf. Also the use of such water for dry planting requires consideration. Analysis of leaf from various areas of Nyasaland (e.g. 1956-7 Report) had indicated a variation in chloride and sulphate content, and some leaf from the Kasungu area was especially high in these two ions. Samples of borehole water used, and also soils from these particular nursery beds were analysed. These were compared with similar samples from the Lisasadzi Demonstration Farm. The chloride and sulphate contents of the five samples were very similar, in the range 1.4-3.6, and 0.5-1.2 p.p. 100,000 respectively. The sodium content of two of the waters was 8 p.p. 100,000, but the sodium absorption ratio was only between 2 and 3. The total soluble salts in the soils was up to 0.05 per cent., and the percentage of sodium in the exchangeable ions was 10 per cent. This was only slightly higher than found in corresponding soils of similar texture taken from the fields (5-8 per cent. sodium). From a comparison of samples taken from other areas of the territory, it would appear that any tendency to soil salinity is more related to the rainfall, and to high temperatures inducing excessive evaporation. The same conclusions may therefore apply to salt content of the leaf.

COTTON

REPORT OF THE COTTON SPECIALIST (E.C.G.C.)

Cotton Breeding

ALBAR 51

Albar 637 is now being multiplied to replace CLB as the commercial cotton of Nyasaland. 200 acres were grown at the Agricultural Production and Marketing Board farm at Toleza; the yield was only 400 lb. per acre of seed cotton, mainly as a result of an attack of American bollworm which developed in spite of regular spraying with Endrin. In the Kholombidzo market area, where 8 tons of seed were planted in African gardens, American bollworm caused so much damage that only one ton of seed cotton was brought to market. The two areas are only some 25 miles apart in the upper Shire Valley, and coincided with the area where American bollworm attack was most severe; it is possible that the insecticides applied aggravated the attack by killing the normal predators.

In the coming season, 200 acres will be planted at Toleza, and about 800 acres in the Chapananga market area in the Lower River.

TABLE I

Cotton Variety Trials

Lint Yields in lb. per acre

<i>Variety</i>	<i>Makanga</i>	<i>Ngabu</i>	<i>Chitala</i>	<i>Lower River</i>
CLB	84	150	228	272
CL.20	112	190	234	—
A.637	124	301	296	328
A.629	114	201	294	273
A.640	143	284	310	280
A.474	125	251	233	—
ABC.30	117	226	248	272
ABC.31	131	—	309	—
ABC.40	126	247	272	—
ABC.109	125	—	286	—
ABC.120	140	268	253	—
ABC.122	113	—	271	—
ABC.146	145	311	281	—
AC.31	139	244	345	—
Sign. Diff.(P=.05)	27	72	44	Not Sign.
S.E.	±9.7	±25.5	±15.8	±22.6
Co-eff. of Var.	20%	22%	15%	40%
Replications	6	6	6	25
Planted	3-12-57	9-12-57	17-12-57	Various

Plot size 1/145 acres. Spacing 3 ft.×3 ft., 3 plants per hole. Station trials were 5×5 balanced lattices; Lower River district plots consisted of a single replication in each garden.

The trials on Makanga and in the Lower River showed a much higher co-efficient of variation than last year; American bollworm and the shedding of apparently undamaged bolls resulted in very poor yields at Makanga, and probably contributed to the high standard error. In spite of this, the Albars again showed a convincing improvement in yield over CLB in the variety trials (Table I). A.637 yielded over 70 lb. more lint per acre than CLB, an increase of 40 per cent.

TABLE II
Spinning Tests

			Effective Length	Maturity Ratio	Standard Fibre Weight	Count Strength Product	Fibre Strength g/tex
<i>Makanga</i>			(1956/57—Trial 7/4)				
CLB	..	..	38	.93	178	2,226	20.6
CL.20	..	..	38	.885	165	2,277	20.8
A.637	..	..	38	.92	176	2,270	21.4
ABC.30	..	..	38	.865	185	2,220	20.6
31	..	..	40	.85	189	2,081	21.2
40	..	..	38	.85	188	2,189	20.4
51	..	..	38	.885	174	2,326	20.6
109	..	..	39	.94	176	2,254	21.7
120	..	..	39	.86	171	2,375	21.5
122	..	..	38	.82	177	2,248	21.8
146	..	..	40	.805	191	2,232	20.9
AC. 31	..	..	39	.865	181	2,262	21.3
<i>Karonga</i>			(1957/58)				
CLB	..	..	38	.98	187	2,087	20.9
A.637	..	..	39	1.00	197	2,034	19.5
CLB (1)	..	..	39	1.035	172	2,239	21.2
CLB (2)	..	..	38	1.035	184	2,000	19.3
CLB (3)	..	..	36	.97	184	1,833	19.4

There was little or no difference in spinning quality between CLB and A.637 in this year's tests (Table II); in all previous tests, A.637 has been consistently better.

SINGLE PLANT SELECTIONS

The single plant selections made in 1957 from A.637 and the related Albars were graded for resistance to jassid and bacterial blight, the latter after needle inoculation with cultured bacterial blight. Some 80 selections have been retained for further observation and testing.

Three recent Albar selections from Namulonge—Albar A (56) 16, 22 and 23—were grown. All these have given high ginning outturns in Uganda, but jassid resistance was found to be only moderate. A few selections which appeared above average for jassid resistance were made.

ALBAR CROSSES

The Albar 49 crosses were tested in the full scale variety trials. As in 1957, they showed improvement over CLB, and one or two appear to be in the same class as A.637 (Tables I and II).

The F₁ of the Albar 51 crosses made last year was grown. UPA (56)5 from Uganda showed rather better jassid resistance than the Albar A(56) selections; this cross, Albar 51 × (MU.8 × BP.52 × BP.52), is among those made here last year.

GINNING PERCENTAGE

Weekly pickings were taken in Trial 8/15; these were ginned separately in order to get more information on the change in ginning percentage through the season reported last year from the records of Chiromo ginnery. There was a very steep rise in ginning percentage from 6th May to the final picking on 10th June (Fig. 1), accompanied by a fall in seed weight. A rise in the lint index from 4.7 to 5.2 means that the lower seed weight does not fully account for the increased ginning percentage, except perhaps in the last picking (See Figs. 1 and 2).

FIG. 1—GINNING PERCENTAGE AND
PICKING DATE

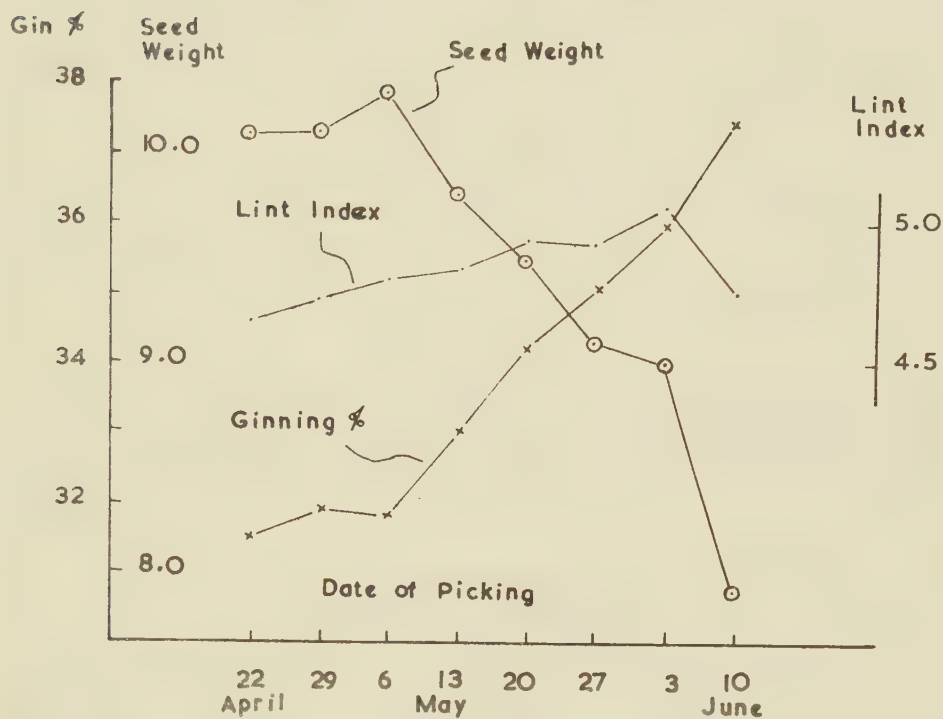
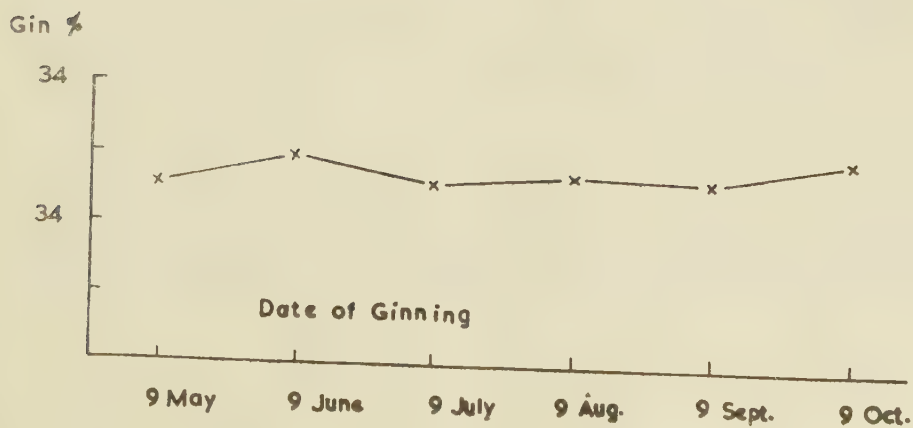


FIG. 2—EFFECT OF STORAGE ON GINNING
PERCENTAGE



Storage of seed cotton has had no appreciable effect on the ginning percentage (Fig. 2).

NORTH NYASA COTTON

Any increase in cotton acreage in the Karonga District must be found in the "dry land" areas—those which are near the rivers, but not normally flooded in the wet season. It is these areas which have gone out of production since 1953, when a peak of 590 tons of seed cotton was reached in the Northern Province. Three samples of seed cotton were chosen by the Agricultural Officer of the district to represent different growing conditions.

CLB (1) ..	..	Best "Dimba" (Flood Land) Cotton.
CLB (2) ..	..	Best Dry Land Cotton.
CLB (3) ..	..	Medium Dry Land Cotton.

These were ginned at Makanga, and sent for spinning tests (Table II). The more difficult growing conditions have resulted in a marked reduction in staple length and yarn strength.

COTTON PEST RESEARCH (C.D.W. SCHEME R817)

Introduction

Investigations based on the programme of work approved by the Federal Research Advisory Committee were continued at the Gatooma Research Station and Makanga Experiment Station. The Research Team was completed by the appointment of the third entomologist who commenced work at Gatooma in March. Toxicological and application aspects of the use of insecticides will now be studied in greater detail.

INVESTIGATIONS AT GATOOMA RESEARCH STATION, SOUTHERN RHODESIA

The effect of cotton insect pest populations cannot be assessed without reference being made to the development of the cotton plant itself, since the state of the plant will determine the degree of insect infestation, and the resulting damage or loss of yield. In the insecticide trials, therefore, measurements of plant development were made. It became apparent that both climatic and agronomic factors were, in certain instances, limiting plant development and subsequent yield of seed cotton, apart from any insect attack. Agronomic factors which were shown to be of importance in retarding plant development during the 1957/58 season, included late sowing, late thinning, poor weeding and a low level of soil fertility, singly or in combination. Apart from soil fertility some of these factors are to a large extent dependent upon climatic conditions.

The 1957/58 season was characterized by erratic and late rainfall at the beginning of the season, followed by heavy rain during January and February. This rainfall distribution made it difficult to sow early on certain farms, and even where this was possible, poor germination and subsequent low stand sometimes occurred due to the lack of "follow-up" rains. The heavy rain in January and February made weeding difficult and also produced waterlogging in some cotton fields.

BIOLOGY OF THE RED BOLLWORM (*Diparopsis castanea* HMPS.)

Rearing of Successive Generations

Successive generations were reared at a constant temperature of 85°F, the first generation being derived from long-term (overwintering) pupae formed in the 1956/57 season. No long-term pupae were formed in the first, second and sixth generations.

In the third, fourth and fifth generations the proportion of long-term pupae was 32 per cent., 10 per cent. and 5 per cent. respectively.

An attempt was made to rear successive generations in the field but it was possible to rear only the first generation during March, owing to the fact that the plants were being denuded of buds and bolls by *Heliothis* larvae. There was a considerable lengthening of all stages of the life cycle and long-term pupae were formed. Assuming that the average total development period of *Diparopsis* (short-term) is approximately 50 days, as found by rearing in March, it would appear unlikely that more than four generations are produced in any one season (December-June inclusive).

Egg Distribution

In Field Trials, 86 per cent. of the *Diparopsis* eggs were found on the plant stems, leaf petioles and growing points, with little or no preference shown between these sites; of the 11 per cent. found on leaves, the greater proportion was found on the upper surface. Eggs were also found on the buds and bolls, so that no part of the plant is completely free.

Egg Loss

There was a considerable loss of eggs during the season, the cause of which still needs determining. The loss of 35-48 per cent. during March rose to 69 per cent. in April. This rise in egg loss is not correlated with weather conditions. The possibility of ants, or other predators which crawl up the plant, was eliminated in last season's experiments. Predators flying directly to plants have still to be considered.

Distribution of Pupae

The distribution of *Diparopsis* pupae overwintering in the soil was determined similarly to last season. The majority were found within 3 inches of the surface evenly distributed under the plants. A small percentage of pupae were found at depths of 4-6 inches, but the presence of pupae at these depths probably depends on the soil structure.

Field Pupation Experiments

Data from the cages set with fifth instar larvae in the pupation gardens has shown that overwintering pupae are not formed until the end of February or beginning of March, after which the proportion produced steadily increased to nearly 100 per cent. by May. The subsequent moth emergence, from September to April with a probable peak in January, does not appear to be correlated with the date of pupation. However, the majority of moths from the short-term pupae emerge four weeks after the larvae have entered the soil. The ant *Dorylus* (*Alaopone*) *conradti* Em. caused a considerable mortality of pupae, which might have had an effect on the moth emergence pattern.

Moth Emergence from a 1956/57 Cotton Field

The pattern of moth emergence from overwintering pupae formed in the 1956/57 season was also determined by 250 field emergence cages, covering a total area of 442 square yards. The ground covered by the cages was kept weeded, and although there was little temperature difference between caged soil and uncaged soil, the effect of bare soil must be considered. The pattern of moth emergence corresponded to that indicated by the pupation experiments. Pupal mortality averaged 68 per cent., and the number of moths emerging was approximately 4,000 per acre. Approximately 185 pupae per acre (4.4 per cent.) were still alive in September 1958, and these will presumably give rise to moths over the 1958/59 season.

Laboratory Pupation Experiments

Pupae incubated at a constant temperature of 85°F, immediately emerge as moths over a period of approximately twenty weeks, with an early peak probably representing the fraction of short-term pupae. Some pupae did not give rise to moths for a considerable time and extended over to a second season.

Attraction Trap Records

Traps were set up at the beginning of the season in various localities in the Gatooma district. Moths were caught near land sown to cotton the previous year and at one farm at least 6 miles from such land. The immediate catch of a fairly high number of moths away from cotton lands suggests the following possibilities:

- (i) The moths originated from the nearest known infested land, 6 miles away.
- (ii) The moths originated from breeding on undetected volunteer plants derived from the previous cotton crops prior to 1956.
- (iii) The moths originated from breeding on unknown host plants.

As moths were only caught at traps near to seedling or ratoon cotton, the cotton plant is probably the primary attraction. The subject of *Diparopsis* moth attraction and the distribution of *Diparopsis* moths needs further study.

The Control of *Diparopsis* and other Pests of Cotton

CHEMICAL

Laboratory insecticide trials have had to await the arrival of the third entomologist and the building and equipping of an insecticide testing room, now completed.

Insecticide Field Trials were carried out on a number of farms and at Gatooma Station during the 1957/58 season. Owing to climatic and agronomic factors yields were depressed in certain instances, and results have not always been conclusive.

Field Trial I: Farm Scale Insecticide Trial

This trial was carried out on a number of farms in the Gatooma/Hartley district and consisted of six unsprayed and six sprayed plots each of four acres and each separated by at least a mile. The objects of the trial were as follows:

1. To measure, in the absence of any interaction between sprayed and unsprayed plots, the effect of the insecticide, Endrin, on cotton insect populations and to determine whether and in what way, increases in cotton yields are related to the control of *Diparopsis* and other pests of cotton.
2. To obtain an overall picture of cotton insect pests of rain-grown cotton in the Gatooma/Hartley district.
3. To measure the build-up of *Diparopsis* on areas where cotton has not previously been grown for at least three seasons.

Spray applications were commenced from first flowers, and, weather permitting, were continued at weekly intervals. The Endrin was sprayed at the rate of $\frac{1}{4}$ lb. active ingredient in 10 gallons water/acre by means of a Leo-Colibri No. 9 pressure retaining knapsack sprayer giving a constant pressure of 50 lb./sq. in. The spray lance was fitted with two T-jet nozzles with D2 Hollow Cone Discs, the plants being sprayed from each side.

The cotton was American Upland, Variety G52/36 which on most plots followed maize. Two plots were fallow the previous season, and two were partly sown to a legume; three had fertilizer applications.

A central sampling area on each plot was divided into four sub-plots. On these records of plant growth and insect populations were taken at fortnightly intervals except on the plots at the Gatooma Research Station where records were twice weekly. Considerable data has been obtained from this trial, a full analysis of which awaits the

advice of a statistician, but a summary of some of the results is given in Tables I and II.

There was no significant increase in yield due to spraying and the percentage of damaged cotton was variable. Comparison between plots is not strictly possible owing to the variation in soil fertility and plant stand, but entomologically certain factors are most important. At the Gatooma Research Station and nearby, cotton had been grown the previous year, and the population of *Diparopsis* was significantly higher here than in other zones. This was reflected in the high egg, larval and pupal populations. It is to be noted that despite the poor plant growth and Endrin spraying, there occurred a very high *Diparopsis* post-treatment build-up on Plot 7 resulting in a high carry-over pupal population. Due to the relatively poor supply of food, the pupae were generally smaller than average. That a poor crop can give rise to a large carry-over population is of great significance. Pupal mortality was high on certain plots, showing that pupal predators are fairly widespread.

The season was characterized by a widespread heavy American bollworm (*Heliothis* sp.) attack which occurred from March to April, and which was not controlled by the Endrin sprays. *Heliothis* preferring buds, affected the late-planted cotton most seriously, as on Plot 2. Plot 2 was unique in having no *Diparopsis* infestation.

Earias and *Dysdercus* spp. populations were generally low. *Earias* populations were reduced by the Endrin treatment and staining was only of importance on Plot 10, which was unsprayed.

The total amount of shedding was not significantly different on the sprayed and unsprayed plots. Maximum shedding occurred from the beginning of March to the end of April, coinciding with the main attack of *Heliothis*. The greater proportion of the shed buds was due to bollworm. The shedding of bolls on Plots 1, 3, 5 and 6 was principally due to causes other than bollworm, and in particular to bacterial blight, perhaps a result of the wet conditions during February.

A cotton boll analysis was carried out for each plot. The low amount of clean cotton from clean bolls, 15 per cent. approximately of total pickable cotton, was typical of all plots. The amount of damaged and lost cotton from bollworm and non-bollworm causes was similar; the latter being principally caused by bacterial blight except on Plot 10, where *Dysdercus* staining was considerable.

Field Trial II: Endrin—Different Rates of Application

Endrin was applied at $\frac{1}{4}$, $\frac{1}{2}$ and 1 lb. in 10 and 20 gallons water per acre by a Leo-Colibri No. 9 knapsack sprayer by eight weekly applications in a randomised block experiment (Table III).

The application of 1 lb. of Endrin just gave a significantly higher yield and a lower percentage damaged cotton, than other treatments, but the increase was not of economic significance. Agronomic and entomological data have been assessed, and show little difference between treatments.

TABLE III
Yield Data from Field Trial II

Treatment				Yield Seed Cotton lb./acre	Per cent. damaged
1.	$\frac{1}{4}$ lb.	Endrin in	10 gals/acre	683	11.1
2.	$\frac{1}{4}$ lb.	" "	20 " "	735	11.1
3.	$\frac{1}{2}$ lb.	" "	10 " "	784	10.1
4.	$\frac{1}{2}$ lb.	" "	20 " "	796	9.0
5.	1 lb.	" "	10 " "	1,016	7.2
6.	1 lb.	" "	20 " "	905	7.3

L.S.D. 219 lb. (P.=05)

TABLE I
Summary of Yields and Agronomic Data from Field Trial I

Zone	Treatment	Plot	Yields lbs. sc. per acre	Per cent. damaged**	Per cent. stand	Sowing date	Regression y for rate of node production to the peak No. of nodes*
I (Gatooma)	S	7b	39	37.0	80.6	10 Dec.	— 328 + 86.6*
		11a	410	15.3	84.0	22 Nov.	— 889 + 151*
	US	8c	269	36.9	97.5	2-8 Nov.	— 706 + 123*
		12a	183	13.8	80.4	22 Nov.	— 1,244 + 196*
II (6-20 miles from Gatooma)	S	6	798	13.3	126.8	2 Nov.	— 1,270 + 204*
		9c	892	9.2	87.0	21 Nov.	— 1,584 + 263*
	US	5	553	23.4	114.2	7 Nov.	— 717 + 132*
		10	514	38.2	62.4	7-8 Nov.	— 2,417 + 317*
III (20-50 miles from Gatooma)	S	2	589	8.3	98.9	12 Dec.	— 438 + 143*
		4b	652	2.3	39.7	13-14 Nov.	— 1,385 + 223*
	US	1a	555	22.9	86.3	26 Nov.	— 856 + 153*
		3b	527	7.4	56.8	18-19 Nov.	— 1,041 + 175*

L.S.D. = 137 lb. (P=0.05) Each regression significant at P=0.05

S = Sprayed

a = Plots received fertilizer

b = Plots fallow previous

** Data from samples of 20 plants.

season.

** Includes staining due to bacterial blight and *Dysdercus* spp. and damage due to boll-

worm.

US = Unsprayed c = Green manure previous to crop.

TABLE II
Summary of Entomological Data from Field Trial I

Zone	Treatment	Plot	Diparopsis Populations			Carry-over Population of live pupae per sq. yd.	Earias larvae per plant	Heliopsis larvae per plant	No Sheds/plant		Per cent. Shedding due to Boltworm	
			Eggs per plant	Larvae per plant	Pupae per square yard				Buds	Bolls	Buds	Bolls
I (Gatooma)	S	7 11	2.96 0.80	1.25 1.80	5.75 2.45	4.00 1.00	0.05 0.15	2.15 2.90	13.8 12.3	12.8 16.5	85.9 83.7	90.5 83.6
	US ..	8 12	2.49 0.41	1.15 1.20	2.15 1.15	0.50 0.10	0.30 1.05	0.80 2.20	16.9 32.4	24.9 16.6	72.6 90.0	55.8 86.3
II (6-20 miles from Gatooma)	S ..	6 9	0.19 0.43	— 0.45	0.30 0.60	0.10 0.05	— —	0.65 1.45	7.7 10.8	25.2 23.4	40.6 64.3	33.7 73.4
	US ..	5 10	0.51 0.51	0.60 0.35	1.05 0.60	0.20 0.30	0.15 0.40	0.30 1.25	8.0 12.1	18.7 36.0	45.2 64.1	33.9 50.1
III (20-50 miles from Gatooma)	S ..	2 4	— 0.04	— —	— 0.05	— —	— —	1.65 1.55	18.0 11.0	16.7 36.0	82.3 73.9	85.9 72.3
	US ..	1 3	0.20 0.09	0.15 0.05	0.30 —	0.25 —	0.25 0.15	0.55 0.40	13.3 11.6	24.8 22.1	48.1 52.9	29.4 41.9

Populations expressed per plant give the total over the whole season.

S = Sprayed.
US = Unsprayed.

Field Trial III: Endrin—Different Methods of Application

Endrin was applied at $\frac{1}{4}$ lb. in 3 and 10 gallons water per acre for eight weekly applications in a randomised block experiment by means of an airblast knapsack sprayer (Fontan R4 Unit) to single and double rows (Table IV). The double row application involved drift spraying through two rows.

Double row applications resulted in a significant decrease in yield. This trial, compared with Trial II, experienced a heavier *Heliothis* attack. There was no significant difference in yield according to the number of gallons applied, particularly with double row applications.

TABLE IV
Yield Data from Field Trial III

Treatment				Yield Seed Cotton lb./acre	Per cent. damaged
1.	10 gals/acre	Single	row application	703	12.5
2.	10	Double	" "	403	17.1
3.	3	Single	" "	577	15.3
4	3	Double	" "	426	18.1

L.S.D. = 151 lb. ($P=0.05$)

Field Trial IV: Miscellaneous Insecticide Trial

Various insecticide treatments were applied for eight weekly applications with a Leo-Colibri knapsack sprayer at ten gallons per acre as shown in Table V.

Sevin gave a significant increase in yield, over the other insecticides, but owing to the fact that it was not possible to take entomological records, the reason for this is not known.

Sevin is to be investigated further during the 1958/59 season.

TABLE V
Yield Data from Field Trial IV

Treatment				Rate in 10 gallons per acre	Yield Seed Cotton lb./acre	Per cent. damaged
1.	Malathion	..	..	10 ozs.	387	10.4
2.	DDT	..	..	1 lb.	466	11.9
3.	DDT + Malathion	..	..	1 lb. + 10 oz.	526	9.3
4.	Endrin	..	..	$\frac{1}{4}$ lb.	490	9.0
5.	Sevin	..	..	1 lb.	741	3.9
6.	Sevin	..	..	2 lb.	780	3.0

Yield: L.S.D. ($P=0.05$) = 160 lb.

CULTURAL METHODS OF CONTROL

To assess the effect of various types of land cultivation on the survival of *Diparopsis* overwintering pupae, two experiments were carried out on land which grew cotton in 1956-57.

Experiment I

Treatments:

1. Rotocultivation to a depth of 5 inches.
2. Disc ploughing to a depth of 8 inches—2 furrow disc plough.
3. Disc ploughing to a depth of 7 inches—6 furrow 1 way disc plough.
4. Control.

Experiment II

Treatments:

5. Hand hoeing as practised in African agriculture.
6. Hand ridging as practised in African agriculture.
7. Double hand hoeing in which the top 4 inches is buried beneath the bottom 4 inches of soil.
8. Mulching uncultivated land with 8 inches layer of loose grass.
9. Control.

None of the treatments materially affected the *Diparopsis* population. The data obtained, which still has to be fully analysed, will provide considerable information on natural pupal mortality.

CONCLUSIONS

The period of *Diparopsis* moth emergence extends over the entire cotton growing season, with a peak emergence in January/February during the past season. *Diparopsis* eggs are laid on all parts of the plant, and are subject to considerable loss, the cause of which is unknown. With a suggested maximum number of four generations during the season, measures must be applied to the crop over a considerable period.

It has been shown by trials carried out over the last two seasons that the most promising method, at present, for increasing yields is by spraying regularly with Endrin. The need for a high potential yield per acre, however, is essential for this control method to be both effective and economic. For this to be attained, sound agronomic practices including early sowing, clean land and a high level of soil fertility are of paramount importance.

Previous season's trials had been mainly concerned with *Diparopsis*. This season infestations of *Diparopsis* were relatively low, but there was a very heavy attack of *Heliothis*, which applications of Endrin failed to control. Further investigations into the chemical control of *Heliothis* are required, and these will be commenced next season. In this connection, however, it has been long established that the decrease in yield as a result of *Heliothis* attack can be considerably reduced by early sowing and sound agronomic practices.

A Farm Scale Insecticide Trial has yielded considerable agronomic and entomological data, the value of which will increase with the continuation of the trial over a number of seasons. Drift spraying over several rows of cotton was carried out, but was shown to be not so effective in increasing yield as spraying each row individually. The insecticide Sevin was used for the first time, and on the result of yield figures only would seem to be a promising insecticide.

Generally, however, the results of the insecticide trials were inconclusive and this was often due to both climatic and agronomic factors retarding plant development.

It has been confirmed that proportionally more overwintering pupae are produced during the latter part of the season, and it has been shown that a certain proportion of

pupae carry over for more than one season. This latter fact is of great importance, especially where an alternate-year cotton policy is to be carried out. Further data obtained, over several seasons and for different areas, however, is required for a full appreciation of the importance of this carry-over.

Pupae were formed principally within the top 3 inches of soil, evenly distributed under the plants.

Considerable pupal mortality was evident in the field. The ant, *Dorylus* (*Alaopone*) *conradti* Em. has previously been shown to be a pupal predator, but further study is required to determine its importance, and the identity of other possible predators.

Various cultivation treatments have been shown not to affect materially the survival of *Diparopsis* pupae.

INVESTIGATIONS ON *DYSDERCUS* SPP. (COTTON STAINERS) AT MAKANGA EXPERIMENT STATION NYASALAND

The approach to the problem of control of stainers was four-fold.

LONG-TERM EXPERIMENT ON THE EFFECT ON *Dysdercus* OF CUTTING DOWN ITS MAJOR PRE-RAINS ALTERNATE HOST, THE TREE *Sterculia africana*.

A circular area of approximately 50,000 acres was selected whose centre is Sorgan. All *S. africana* were cut down in the area, a total of 3,891 trees. The effect of this operation requires to be studied over a period of at least three years before any conclusions may be drawn.

Weekly records were made of the insects on other alternate hosts in the area, and on seventeen selected cotton fields which were both in the area and outside it. In the circle three fields were on a radius at each point of the compass, making four fields at the centre of the circle, four approximately $2\frac{1}{2}$ -3 miles from the centre, and four near the perimeter. The other five fields were situated outside the circle. Population counts both on these and other gardens in the Lower River district were taken, and showed a comparatively very low *Dysdercus* population throughout the Lower River and throughout the season. This largely explains why results this season are inconclusive. In addition, seed cotton yields and grades were recorded from each field.

In the experiment there was no significant difference between total yields of the groups of fields at different distances from the centre, or between these fields and those in outside areas, nor was the difference in the amount of Grade II cotton marked. Unfortunately it was not possible to persuade growers to pick all their Grade II cotton in every case.

Initially, numbers of *Dysdercus* were greater in fields near the perimeter, but later in the season little variation was found and the numbers were too small to be of any significance.

It should be pointed out that the felling of the *Sterculia* trees was not completed until 21st December, too late to be likely to seriously curtail breeding on many of the trees. The experiment is being continued and a greater number of records will be taken in 1958/59.

CHEMICAL CONTROL OF *Dysdercus* ON ALTERNATE HOSTS

Preliminary experiments were carried out this season to test the effect of persistent soil-insecticides sprayed on the trunk and on the soil under the canopy of *S. africana*. Great difficulty was experienced in finding seriously infested hosts, and in the end trees supporting very low stainer populations had to be used.

Due to this and because the effect cannot be measured in one season, results were inconclusive although Dieldrin showed more promise than Chlordane. Next season experiments will be continued on a larger scale if conditions allow.

CHEMICAL CONTROL OF *Dysdercus* ON THE COTTON CROP

Although *Dysdercus* may be killed by a range of insecticides using six to ten or more applications in the season, this is uneconomic and impracticable under conditions of agriculture and climate in the Lower River. Experiments were therefore initiated using persistent insecticides (chiefly Chlordane, Dieldrin and Aldrin) at relatively heavy dosages, the hypothesis being that, with such insecticides, only one or two applications might be necessary in a season. While plants "grow away" from these insecticides, *Dysdercus* concentrate their attack on the more mature green bolls which first form on the lower sympodia. The effect of rain wash was not great but needs to be studied further.

As in other experiments, the effect of treatments was masked due to the very low populations of *Dysdercus* this season, and in only one experiment (see Table VI) was there a significant difference at the 5 per cent. level between total yields. The relatively heavy rate of 5 lb. active ingredient per acre was used.

TABLE VI
Yield of Seed Cotton per acre (lb.)

Block					Aldrin	Dieldrin	Control
I	..	..	..	..	341	528	196
II	..	..	..	..	392	541	214
III	..	..	..	..	492	464	287
Mean	..	..	..	..	408	511	232

It is considered that the increase in yield in the treated plots was largely due to the control of insects other than *Dysdercus* and the differences in the amount of Grade II cotton (shown below as Table VII and expressed as a percentage of total yield) were disappointing.

TABLE VII

Dieldrin plots	..	..	..	..	28 per cent
Aldrin plots	..	..	..	..	25 per cent
Control plots	..	..	..	..	33 per cent

Records of dead and live *Dysdercus* taken each week indicated little or no interaction between plots with an average 80-90 per cent. mortality in treated plots and some 2-3 per cent. mortality in control plots.

BIOTIC CONTROL OF *Dysdercus*

Experiments were carried out using a predaceous Reduviid, *Phonoctonus nigrofasciatus*. This insect is only likely to be of use in conjunction with other methods of control and not as a control *per se*. It holds most promise for use in connection with the partial eradication of *S. africana*, but releases were also made this season on selected cotton fields as well as on alternate host trees.

In cotton fields it was found that there was too great a tendency for the predators to wander and that vast numbers would be needed to effect an adequate control. Although control of *Dysdercus* in cotton fields by this means have never been seriously considered at any time, some interesting data were obtained following their release.

More promising results were obtained in an experiment on the release of predators to control *Dysdercus* on *S. africana*. In this experiment three releases each consisting of 10 fifth instar *P. nigrofasciatus* were made on each of 10 trees, but due to the low numbers of *Dysdercus* another closely related Pyrrhocorid, *Odontopus exsanguis*, had to be used as an indicator insect. The predator feeds only on Pyrrhocorids and survives in the dry season chiefly on *Odontopus*.

On all these trees a very considerable decrease in host insects occurred, while host insects on control trees increased. The results indicate the need for further experiments next season.

OTHER WORK

Routine population records of *Dysdercus* and associated insects were continued. Data concerning migration and inter-host movements, breeding peaks and seasonal activity, life cycles and syneecology, etc., confirmed in the main results of the work of the previous season with minor variations.

It was confirmed that there are several major ecological areas in the Lower River where the host-sequence, host importance and inter-host movements vary and that each area requires special study. Preliminary investigations and records were commenced this season in each of these areas.

A new breeding host (*Trichilia roka*) was discovered, a tree unrelated to cotton. This discovery adumbrates the need for extending investigations concerning alternate hosts outside the Malvaceae and related families.

Experiments with marked *Dysdercus* showed that flights were possible over a distance of at least 3 miles, but that 1 mile or under was the normal limit. Further experiments are required, however, since recovery of marked specimens was very small. The maximum migration distance for normal flight is thought to be no more than 5 miles here, which is made in a series of shorter flights. Carried by wind or lacking food, the distance travelled by an individual may be greater.

A replicated experiment with caged single plants to determine if stainers caused shedding of bolls confirmed a previous experiment, and showed that no shedding was caused under the experimental conditions.

ROTATIONS

1. EFFECTS OF GREEN MANURING

An experiment was carried out at Chitedze to compare sunnhemp, velvet beans and soya beans as green manures when planted at end of December, mid January or early February and turned in after 2, 3 or 4 months growth. It showed that the variety of soya bean used, Pelican, was much inferior to either velvet bean or sunnhemp, which gave the highest yields of maize in the following crop. It pays to plant the green manure before the new year, but this experiment showed little difference between the ages at which the crop was turned in. The experiment is being repeated. The soya variety Pelican is a seed producer not a hay variety, and it is probable that one of the late, tall-growing varieties such as Malaya or Benares would be much more suitable as a green manure. Soya once established has the advantages, unlike sunnhemp, of having no major pest or disease in this country and of being easier to disc up and plough in than the rather tangled, wiry velvet bean. An observation on the method of disposal of velvet beans showed that the following maize crop yielded very much less if the beans were cut and dried before ploughing in than if they were turned in green. Maize yields were further reduced if the beans were cut for hay and removed or if they were taken for seed.

2. PLOUGHING OUT RHODES GRASS

At Chitedze plots were returned to arable cultivation in March, 1957, after 5 years unfertilized Rhodes grass by tractor ploughing, ox ploughing and by hand cultivation. Mechanical cultivation penetrated much more deeply than the hand cultivation, i.e. 6-8" as opposed to about 3", but the planting ridges on all plots were cloddy and charged with undecayed organic matter. Yields were compared with neighbouring plots which had been ploughed the season before and had already grown a test crop of maize. All maize and tobacco plots were split for fertilizer and no fertilizer, the fertilizer treatment being 200 lb. per acre sulphate of ammonia for the maize and 200 lb. per acre sulphate of ammonia plus 200 lb. per acre "C" mixture on the tobacco.

TABLE I

Yields of Maize, Groundnuts and Tobacco after Rhodes grass

Varieties: Namalenga Maize, Mwitunde Groundnut and Western Tobacco

Yields: lb. per acre marketable produce

Treatment	Maize		Groundnuts	Tobacco yield		Tobacco Grade Index	
	Nil	Fert.	Nil	Nil	Fert.	Nil	Fert.
1st Crop after Rhodes:							
Hand cultivated	995	2,875	1,011	538	1,032	38.8	41.3
Ox ploughed	2,661	2,962	929	603	928	56.5	55.5
Tractor ploughed	2,384	2,958	888	460	1,101	39.4	50.5
Mean 1st Crop	2,013	2,932	943	525	1,032	44.9	48.9
2nd Crop after Maize	1,993	3,513	1,313	419	1,019	39.5	44.9

In the Mphanje B experiment, plots ploughed out of the same Rhodes and adjacent bush grass in March, 1956, and planted to maize with and without fertilizer and to various unfertilized legumes in 1956/57 season were again cropped with maize, groundnuts and tobacco to test the residual effect of the previous treatment. These were compared with plots ploughed up in March, 1957, both from Rhodes and bush grass on the boundaries of the above plots. Half this season's maize crop received no fertilizer and half 200 lb. per acre of sulphate of ammonia. The tobacco and groundnuts were unfertilized. Certain of the plots ploughed from Rhodes in March, 1957, were given 100 lb. per acre sulphate of ammonia at the time of ploughing to encourage rotting of the organic matter.

TABLE II

Yields of Maize, Groundnuts and Tobacco after ploughing Rhodes and Bush

Varieties: Namalenga Maize, Mwitunde Groundnuts, Western Tobacco
Yields: lb. per acre marketable produce

<i>Treatment</i>	<i>Maize '58</i>		<i>G-nuts '58</i>	<i>Tobacco '58</i>	
	<i>Nil</i>	<i>200 lb./acre S/A</i>		<i>Yield</i>	<i>Grade Index</i>
1st Arable Crop after:					
Bush	456	3,063	905	181	17.5
Rhodes grass ..	1,177	2,916	896	258	19.2
Rhodes + 100 lb. S/A ..	1,644	3,248	837	376	15.2
2nd Arable Crop after:					
Maize in '57 with					
N ₀ Nil	1,581	2,770	1,141	311	20.3
N ₁ 100 lb. S/A ..	1,639	2,639	1,177	315	19.4
N ₂ 200 lb. S/A ..	1,598	2,492	1,121	299	16.5
P ₀ Nil	1,594	2,250	1,087	312	18.2
P ₁ 200 lb. Supers ..	1,619	3,017	1,206	304	19.3
Groundnut seed '57 ..	3,348	3,002	656	420	17.8
Groundnut hay '57 ..	2,841	3,190	773	437	17.8
Soya seed '57 ..	2,284	3,098	925	304	17.9
Soya hay '57 ..	2,385	2,830	949	455	17.4
Cowpea seed '57 ..	2,627	3,509	913	214	17.1
Beans seed '57 ..	3,072	3,202	995	170	18.1

3. LONG TERM ROTATION EXPERIMENT

Rotation No. 1 at Chitedze, Tuchila and Mbawa, testing rotations of various lengths including bush fallows treated in various ways, gave results similar to previous years, as did Rotation No. 4 at Chitedze, which tests rotations based on green manuring.

TABLE III

This year's results of long term Rotation Experiments Nos. 1 and 4

Variety: Local Selections.

Yields: lb. per acre grains.

No. 1 Maize after				Chitedze		Tuchila		Mbawa	
				0	100 lb. S/A	0	100 lb. S/A	0	100 lb. S/A
1 year maize	..	..	..	2,079	2,850	490	1,001	218	825
2 years maize	..	..	..	1,524	2,721	720	1,039	286	825
3 years maize	..	..	..	1,647	1,886	154	390	292	704
4 years maize	..	..	..	1,588	2,096	165	374	183	733
5 years maize	..	..	..	—	—	55	412	395	687
Groundnuts	..	..	..	2,570	3,025	557	1,298	472	1,331
Sunn hemp	..	..	..	1,215	2,009	632	2,447	132	973
Velvet beans	..	..	..	2,365	2,692	1,581	2,200	478	1,054
Bush fallow	..	..	..	1,933	2,844	1,215	2,139	263	861
Pigeon pea fallow	..	..	..	2,862	2,920	1,545	2,068	355	570
After 1 yr. maize 56/57	..	..	..	2,408	3,254	853	1,548	50	512
„ 1 „ „ 55/56	..	..	..	2,055	2,395	923	1,523	158	823
„ 1 „ „ 54/55	..	..	..	1,479	2,131	917	1,998	449	1,287
„ 1 „ „ 53/54	..	..	..	—	—	852	1,469	—	—

No. 4 Maize after				At Chitedze only		
				N ₀ N.	75 lb./ acre S/A	150 lb./ acre S/A
1 year maize	..	..	..	2,447	2,721	3,072
2 years maize	..	..	..	2,950	2,610	2,756
Groundnuts	..	..	..	2,675	3,375	3,510
Sunn hemp G.M.	..	..	..	2,867	3,224	3,702
Velvet bean G.M.	..	..	..	2,902	3,358	2,780
Bulrush millet G.M.	..	..	..	2,832	2,812	2,897
After 1 yr. maize 56/57	..	..	..	2,513	2,767	2,820
„ 1 „ „ 55/56	..	..	..	2,420	2,765	2,535
„ 1 „ „ 54/55	..	..	..	1,666	1,917	2,347

At Chitedze yields have been maintained on average by these rotations and at Tuchila yields have been maintained until this year. At Mbawa however the yields have fluctuated wildly and are so low that it seems that rotations based on up to 5 years bush fallow, with little artificial nitrogen and no farmyard manure, are quite inadequate for this rather poor type of soil. In another experiment conducted nearby, Rotation No. 3, testing the effects of organic and inorganic manures on continuous maize, yields have been maintained by the use of 5 tons per acre farmyard manure and a little nitrogen. In the same No. 3 experiment conducted on rich red loam at Chitedze a much higher yield of maize has not been maintained by the manures and fertilizers applied.

TABLE IV
Responses of Continuous Maize to organic and artificial Manures
Variety: Local Selections. Yields: lb. per acre grain

<i>Treatment</i>	<i>Chitedze</i>	<i>Mbawa</i>
2½ tons per acre F.Y.M.	2,463	—
5 tons per acre F.Y.M.	2,880	—
Mean F.Y.M.	2,671	1,939
Control—no Organic Manure	2,159	612
Mean Compost	2,367	2,103
5 tons per acre Compost	2,301	—
2½ tons per acre Compost	2,434	—
Nil	2,125	1,360
75 lb. per acre S/A	2,672	1,743
Response	+547	+383
Nil	2,285	1,566
100 lb. per acre Superphosphate . . .	2,512	1,537
Response	+227	—29
Mean 1957/58	2,399	1,551
Mean 1956/57	2,998	1,451
Mean 1955/56	3,724	1,142
Mean 1954/55	—	2,347

4. RIDGING AND MULCHING EXPERIMENT, MAKANGA

This experiment was planted to cotton in the 1957/58 season, with results somewhat similar to those in the past for maize.

TABLE V
Results of Ridging and Mulching Trial, Makanga

Variety: See Table Yields: lb./acre grain or seed cotton

Year	1953/54	1954/55	1955/56	1956/57	1957/58
Crop	Maize	Maize	—	Maize	Cotton
Variety	Local	Local	—	Local	Albar 637
Rainfall	14.8"	28.8"	—	28.4"	21.4"
Flat	230	1,653		2,066	806
Ridge	331***	1,592	F	2,243	783
Ridge and Box	441***	1,634	L	2,373**	814
			O		
No mulch	206	1,640	O	1,777	705
Light mulch	361***	1,683	D	2,047*	876**
Heavy mulch	433***	1,557	E	2,857***	821*
			D		
Mean	334	1,626	—	2,227	800
L.S.D.	15	139	—	227	96
Coef. of Var.	33.3%	12.7%	.	15.1%	18.0%

It is better to plant maize on ridges in all but the wettest years, but in the one year's results available to date it makes no difference to the yield of cotton whether it is planted on the ridge or on the flat. In all but the wettest years mulching gives an increase in yield, and the drier the year the greater the benefit of the mulch.

5. PREPARATION OF GARDENS TRIAL, MAKANGA

In the 1957/58 season this trial was planted for the last time to groundnuts. Difference between treatments have been very small and significance where it occurs has not been consistent.

TABLE VI

Results of Preparation of Gardens Experiment, Makanga

Variety: CLB Cotton and Station bunch groundnuts

Yields: lb./acre seed cotton and shelled nuts

<i>Treatment</i>	<i>Year Crop</i>	1954/55 Cotton	1955/56	1956/57 Cotton	1957/58 Groundnuts
Leave stover as mulch		663	F	1,406	615
Burn stover		721	L	1,356	659**
Prepare land early (May)		633	O	1,461***	631
Prepare land late (November)		751***	O	1,301	643
Ridges split		715	D	1,356	661**
Ridges scuffed up		669	E	1,406	612
Large ridges made initially		667	D	1,376	632
Small initial ridges enlarged at time of weeding		717		1,387	642
Mean		692	—	1,381	637
L.S.D. 5 per cent.		87	—	86	30
Coefficient of Variation		24.9%	—	12.3%	9.2%

Cotton again appears to be remarkably insensitive to variations in time and method of preparing the land, the small differences being reversed in most cases in 56/57 as compared with 54/55 season. For groundnut cultivation there does however appear to be benefit from burning the stover rather than leaving it as a mulch, and from splitting the ridges rather than scuffing them up.

6. Mixed Farm Unit

ROTATIONS AND GRASSLAND OBSERVATIONS AND EXPERIMENTS

It is the function of the Bvumbwe Agricultural Experiment Station to serve the needs of the local European farming and plantation enterprise. In 1952 it appeared that the tung industry would no longer be able to expand as originally anticipated and alternative means of agricultural production were sought. Accordingly an investigational mixed farm unit was started in 1953. The unit was planned to be 100 acres in size with half on an arable/ley rotation and half laid down to permanent pasture. It was decided that stocking with dairy cattle would be more practical economics than a beef herd on such a small unit and so a pedigree Jersey herd was built up. Difficulties in purchasing suitable stock meant that the herd did not reach full production until the second half of this year. The milk is processed on the station into butter and a herd of Large White pigs is kept as an outlet for the skim milk. The end products of the unit are therefore butter and pork. It was also expected that some of the soya grown in the arable break and surplus to requirements would find a ready sale.

1. COST OF UNIT

Separate accounts were kept for the unit and costs were worked out for the crops and livestock. Overheads are estimated to be covered by an additional cost of 20-25 per cent.; for the purposes of this exercise they were taken at 25 per cent.

(i) *Crops*

TABLE VII
Costs of Production

Item	Cost per bag of 200 lb. net						Cost per short ton					
	Maize			Soya			Silage					
	£	s	d	£	s	d	£	s	d			
Labour	—	5	10	1	4	8	—	4	3			
Tractor	—	2	1	—	4	2	—	4	6			
Seeds	—	0	6	—	2	4	—					
Fertilizer	—	2	8	—			—	3	9			
Miscellaneous	—	0	11	—	1	6	—					
25 per cent. Overheads	—	3	0	—	8	2	—	3	2			
	£—	15	0	£2	0	10	£—	15	8			

Sixteen acres of maize were planted yielding 288 ($\times$ 200 lb.) bags, i.e., 18 bags per acre. $7\frac{1}{2}$ acres of soya were planted yielding 11,474 lb., i.e., $8\frac{1}{2}$ ($\times$ 200 lb.) bags per acre. Costs of production of maize and soya were very satisfactory, in spite of the fact that the yield of the latter was slightly lower than the average for previous years. Maize and soya were grown as feeds for livestock; surplus soya was easy to dispose of as seed. 12 acres of Rhodes grass and 4 acres of Napier were turned into an estimated 180 short tons of silage.

(ii) *Livestock*

The pig production has been geared to the amount of skim milk available; it has therefore not reached its maximum level. Difficulties have also been experienced in finding a ready market for pork and a large proportion of the stock has had to be sold to local Africans as weaners. A small profit of £68 representing 16 per cent. of the turnover was realized.

The dairy cattle enterprise had not yet reached the stage of full production but the technical difficulties of milk production have been satisfactorily solved. Ample silage was produced for dry season feed. This year there was sufficient rain to keep the pastures productive throughout most of the dry season and there will be a considerable reserve of silage for next year. Concentrates contained, in the main, locally produced maize and soya. The herd average was 661 gallons which for Jersey cattle in their first lactation in a sub-tropical country is a very reasonable yield. It is expected to publish detailed costs of the livestock in the next report when they will have been in full production for the whole period. The unit should be able to maintain about 20 cows with followers and bull.

2. ROTATION

The arable/ley part of the mixed farm is planned on a six-course rotation, viz., maize, soya, maize, three-year ley. Star grass was originally selected as a ley grass but it quickly proved difficult to eradicate and is now used for permanent pastures only. The Mpwapwa strain of Rhodes grass was selected as being the most suitable ley grass and this year the first grass/legume pasture of Rhodes, Fiji clover (*Desmodium intortum*) and *Stylosanthes* has been successfully established. Napier is introduced in one of the three leys for silage-making.

A standard fertilizer dressing for all pastures, based on previous experiments with Star grass and Rhodes grass, is 400 lb. per acre of sulphate of ammonia applied in split dressings. The legumes, which have hitherto been planted in strips, are band fertilized with superphosphate at the rate of 200 lb. per acre.

Five years of the arable/ley cycle have now been completed and Table VIII below shows the relative effects of growing maize after a ley compared with after soya.

TABLE VIII
Maize, Yield bags grain per acre

<i>Field</i>	<i>1 After ley</i>	<i>2 After soya</i>	<i>Remarks</i>
A	17.4	21.5	Star grass ley
B	13.1	15.5	Napier ley
E	10.0	15.0	Rhodes grass ley
F	11.5	13.6	1. After scrubland cleared for maize

In all instances a greater yield was obtained after soya.

To counteract the low yields after a ley, higher rates of nitrogenous fertilizer are required. An overall higher yield is also required with an average, if possible, of 20 bags per acre. The following changes have therefore been made:

(i) Maize after soya will receive 150 lb. per acre sulphate of ammonia and maize after ley 250 lb. per acre;

(ii) Maize after ley will be planted in 3 foot rows with a higher plant population than maize after soya in 7 foot rows;

(iii) A higher yielding variety than Namalenga is being sought and preliminary observations with new selections have suggested the introduction of Synthetic 13.

A further defect of the rotation is the length of the ley. It is usually established by interplanting maize in 7 ft. rows at about tasselling time. Rhodes grass sown in February produces a pasture fit for light grazing by October. It is then ploughed for the arable break in March-April, three years after sowing, maize being planted in the November. With a six course rotation containing 3 arable crop seasons, it follows that the ley has a productive life of only $2\frac{1}{2}$ years. This is less than the useful life of Rhodes grass which maintains its productivity at Bvumbwe for at least 4 years. Therefore a further field has been introduced to make a 7 course rotation with a 4 years' ley.

GRASSLAND EXPERIMENTS AND OBSERVATIONS

I. VARIETIES

A replicated variety trial of some of the more promising grasses at Chitedze, managed on an alternate grazing and mowing system, has shown the Bua strain of *Setaria sphacelata* to be the highest yielder to date. The small response to sulphate of ammonia so far is accounted for by the youth of the grass and the fertility of the red loam soil which has hardly been cropped at all. The grasses most readily grazed are the Rhodes and Makarikari. The palatability of the *Cenchrus* improves as the dry season approaches because it stays green longer than the others. The plots were planted in January, 1957.

TABLE I
Yields of sundry grass varieties at Chitedze
Yields in short tons per acre green weight

Variety	1957		1958		Means 1958
	No Ferti- lizers		No Fert.	400 lb./acre S/A	
Setaria, Bua	1.38		5.22	7.62	6.42
Star grass	0.97		1.58	3.42	2.50
Makarikari	2.64		3.33	4.62	3.97
Rhodes, Katambora	2.86		3.30	5.31	4.30
Rhodes, Teso	2.78		2.47	4.24	3.35
Cenchrus, Cipinga	1.04		3.75	4.10	3.92
Mean	1.95		3.28	4.89	4.08

Of recent introductions, the creeping strains of Makarikari have established themselves and spread vigorously this season. Two strains of *Setaria sphacelata* from Uganda have grown well from seed, but they are not as vigorous as the Bua, Chitala and Kazungula types. It has still not been possible to harvest viable seed from the *Panicum* or the *Setaria* species at Chitedze. What is not smutted seems to be non-viable.

In the Northern Province, Rhodes grass and Makarikari seem to give most promise at Baka and Karonga, while at Yembe Hill, a badly eroded site not far from Baka, Makarikari, *Paspalum urvillii* and *Acroceras macrum* give the best results.

Indigofera subulata continued to grow well at Chitedze but all the leaves have now died back and it may prove to be a biennial. *Desmodium intortum* and *Atylosia scarabeoides* continued to grow fairly well, but not as vigorously as the present favourites, nor do they seed freely. *Aschynomene americana*, *Clitoria* sp., *Indigofera hirsuta*, *Desmodium discolor* and *Stylosanthes gracilis* are those which so far combine good seed set with vigorous nodulation and a fair degree of palatability. These and others were sown in mixtures with Rhodes and other grasses in February, 1958, but the early ending of the rains reduced germination and retarded growth.

ESTABLISHMENT OF RHODES GRASS

Rhodes grass seed sown in January under well cleaned maize drilled in $3\frac{1}{2}$ ft. rows germinated well, especially where it was sown with superphosphate as a filler.

The soil of this particular field at Chitedze is a little deficient in phosphate. Sulphate of ammonia appeared to make no difference. By the end of February, when the rain stopped, there was quite a thick carpet of young grass, but whether it will withstand the long drought remains to be seen. Cuttings planted at the same time have suffered badly. On another site, bare and well cleaned ground was sown with Rhodes grass seed at fortnightly intervals from 20th November to 25th February. The last sowing did not germinate properly, but a good cover was obtained from sowings made before the end of January. December sowings gave a useful cut in early February and all plots had to be cut again in May. Seed rates used were between 10 and 15 lb. per acre of seed, in glume, as it is removed from the flower head. This has a germination percentage of between 10 and 20 per cent.

3. MANAGEMENT OF RHODES GRASS

The Rhodes grass management trial at Chitedze was cut once on 5th February before being ploughed up. Only the December dressings of fertilizer were applied.

TABLE II
Results of Rhodes grass Management Trial, Chitedze
Variety: Teso *Yields: Short tons/acre green weight*

<i>Treatments</i>	1955/56	1956/57	1957/58 1 cut only	<i>Residual effects 57/58 of Fert. applied in past</i>
Nil	4.74	4.63	2.09	2.09
200 lb. per acre S/A	7.31	8.47	5.42	2.07
400 lb. per acre S/A	10.92	12.23	7.11	2.99
All applied in Dec. before rains	8.55	9.17	—	
½ December and ½ January	8.69	10.12	—	
All applied in Jan. after 1st cut	10.09	11.76		
One cut taken	9.67	10.97	3.18	} These numbers of cuts taken in the past.
Two cuts taken	7.96	10.03	3.54	
Three cuts taken	5.34	4.33	4.60	
Mean	7.66	8.41	3.77	} 1 cut only be- fore ploughing.

It appears from these figures that:

- (1) It is best to have two cuts or grazing periods per year.
- (2) That there are very large responses to sulphate of ammonia, though whether these are economic it is difficult to assess, the production and marketing of livestock products being still in their infancy in this country.
- (3) That the nitrogen top dressings should be applied after the first cut if they are no more than 200 lb. per acre S/A, but should be split and applied at the beginning of each production period if they are 400 lb. per acre or more.
- (4) There is little residual response after a cut has been taken to dressings under 400 lb. per acre of sulphate of ammonia.

4. CARRYING CAPACITY OF RHODES GRASS

At Tuchila, 6.0 acres of unfertilized Rhodes grass were utilized by three adult beasts as follows. 2.7 acres provided grazing for the first three months of the rains allowing 3.3 acres to be cut for hay or silage which yielded a total of 8.9 tons of green material. Aftermath grazing over the whole area lasted to the end of May,

when the cattle ceased to put on weight. Live weight gain per day was 1.23 lb. Assuming that 1 beast needs 1 ton of green material conserved for each month of inadequate grazing this ley would carry one beast to between 3.0 and 3.5 acres throughout the year.

Six acres of Rhodes fertilized with 200 lb. per acre of sulphate of ammonia were utilized by three adult cattle as follows. 1.1 acres provided grazing for the first three months or so of the rains allowing 4.9 acres to be cut for hay or silage which yielded a total of 42.1 tons of green material. Aftermath grazing over the whole area lasted to the end of August when the cattle had ceased to put on weight. Live weight gain per day was 1.37 lb. Assuming that 1 beast needs 1 ton of green material conserved for each month of inadequate grazing this ley would carry 1 beast to between 1.0 and 1.25 acres throughout the year.

5. FERTILIZER TRIAL ON MAKARIKARI

At Mbawa a fertilizer trial on Makarikari has reached its third year. This year's results are very similar to those in past years. The fertilizer was applied in two doses, early and mid season.

TABLE III
Yields from a Fertilizer Trial on Makarikari at Mbawa
Variety: Makarikari. Yields: Short tons/acre green material

<i>Treatments applied each year</i>	<i>Yield/acre</i>	<i>Grazing hours per beast per acre</i>
N ₀ Nil	5.08	3,061
N ₁ 300 lb. S/A per acre	10.93***	5,834***
N ₂ 600 lb. S/A per acre	14.50***	6,086***
P ₀ Nil	9.59	4,852
P ₁ 300 lb. Supers per acre	10.61	4,973
P ₂ 600 lb. Supers per acre	10.30	5,156
D ₀ Nil	8.79	4,829
D ₁ 5 tons per acre F.Y.M.	9.71	4,874
D ₂ 10 tons per acre F.Y.M.	12.01	5,278
Mean	10.17	4,994
L.S.D. = 5 per cent.	1.48	571
Coefficient of Variation	12.6%	9.9%

This site is not short of phosphate though the soil is poor. The dung does not greatly benefit the pasture, though it may have a marked effect on the crops planted after the grass has been ploughed up. It is probably better applied directly to the arable crops on this sort of soil.

6. MANAGEMENT OF NAPIER GRASS AT TUCHILA

A 7½ acre field of Napier grass (West Coast strains) which was planted under maize in February, 1956, yielded 25 tons of green material per acre for silage in February, 1957, and the aftermath subsequently afforded valuable dry season grazing. It was dressed with 10 tons of FYM per acre in July, 1957, and early in January, 1958, received a top dressing of 200 lb. per acre of sulphate of ammonia. In February it was cut for silage, yielding 26.6 tons of green material per acre. The aftermath was grazed in April with 169 adult cattle for 7 days (i.e., 158 grazing days per acre). At present (August, 1958) there is a good growth of grass and further grazing will be possible through the dry season.

7. AFTER-EFFECT OF RHODES GRASS LEY AT TUCHILA

A Rhodes grass ley sown under maize in 1953 was ploughed out in February, 1957, after very heavy grazing by cattle and sheep. At the time of ploughing the weather was unseasonably dry and penetration was difficult but the turf was fairly effectively turned in with cross-ploughing. No catch crop was taken. The ground remained rough and cloddy even after cultivation immediately prior to the rains of 1957/58.

There was no apparent depressing effect on maize planted on this land in December, 1957, nor on tobacco, which grew extremely well. Germination of maize, however, was on the whole poor, partly due to lack of rain after planting and partly to the cloddy state of the soil. The soil structure had obviously improved and is still (August, 1958) much better than any other cultivated field at Tuchila. Soil samples received the following comments from the Agricultural Chemist:

" Their content of organic matter is about 50 per cent. higher and this is reflected in the greater base exchange capacity and the nitrogen content. The potash status is also rather higher."

8. GRASSLAND OBSERVATIONS, BVUMBWE

The permanent pastures of the mixed farm unit at Bvumbwe, described in the rotation section of this report, are planted on land unsuitable for arable crop rotation, mainly sand overlying laterite or light sandy soil overlying mottled clay. *Cynodon dactylon* Star No. 2 is the usual grass planted. In an area where laterite banding has caused waterlogging camber beds have been successfully established alternately to Kikuyu and Star grasses; the Kikuyu is proving more palatable than the Star and provides a green bite for a longer period in the dry season. A further section of Star embraces a long term fertilizer trial. A selection of grasses and legumes from the museum plots are also on trial in a series of one-acre plots for grazing observations. Protein values of the different plots have already been published (Annual Report, Part II, 1956/57, pp. 57-58) and the table gives a comparison of the productivity of each.

TABLE IV

One Acre Grazing Plots

Grazing material provided, period 1-7-57 to 30-6-58

Plot	Dry weight in cut. per acre	Months grazed or mown	Remarks
<i>Cynodon plectostachyus</i> (Star No. 2)	99.9	August, December, January, April and May	Mixed with <i>Aeschynomene americana</i> and <i>Desmodium intortum</i> .
<i>Chloris gayana</i> (Mpwapwa and Teso Rhodes)	79.1	July, October, January, April and June	October bite consisted of foggage and <i>Desmodium intortum</i> which was killed out by over-grazing.
<i>Panicum coloratum</i> var. <i>makarikariensis</i> (Makarikari)	62.7	August, December, January, February, March and April	Provided a green bite in August. Liable to be suppressed by weeds in the rains. Planted with <i>Desmodium intortum</i> , <i>Glycine javanica</i> and <i>Teramnus uncinatus</i> .
<i>Cenchrus ciliaris</i> (African Foxtail)	45.4	August, October, November	Produced well in the dry season. Planted with <i>Stylosanthes gracilis</i> to make a satisfactory mixture.
<i>Panicum coloratum</i> var. <i>makarikari</i> (Strain Bambatsi)	41.3	January and April	Pure stand, no legume. Very weedy.
<i>Acroceras macrum</i> (Nile grass)	26.6	March and June	Suffered from drought.
<i>Chloris gayana</i> (Katambora Rhodes)	24.6	January and April	Pigeon pea planted in hedges 20 feet apart.
<i>Phalaris hybrid</i> (Rompha grass)	23.3	March and May	—
<i>Paspalum dilatatum</i> (Dallis grass)	22.3	February, April and June	Interplanted with <i>Centrosema pubescens</i> . Weedy.

The plots were grazed off whenever there was enough material and then topped with a mower. Samples were taken to estimate (i) productivity, (ii) amount grazed, (iii) grass/legume ratio before and after grazing.

A record was kept of the effect of the plots on the milk yields, comparisons being made with average yields for preceding and succeeding periods. Mpwapwa Rhodes grass with Fiji clover (*Desmodium intortum*) maintained milk yields better than Star in the rains. In the dry season, when Rhodes provided a poor bite, the African foxtail (*Cenchrus ciliaris*) was outstanding. Makarikari produced the bulk but not enough leaf and failed to maintain milk yields; it was also less able to withstand weed competition. Rompha was outstanding for its protein content (23.8 per cent.) and no deleterious effects were noticed on oxen grazing in March and May. The Fiji clover, with a protein content of 32.2 per cent. and a root system that can reach as deep as 11 feet, is the best legume found for non-irrigated pastures. It is extremely palatable to cattle and is thus liable to be overgrazed, therefore management will have to be adjusted to its needs.

Grasses in the museum plots suitable for further trial are Molasses (*Melinis minutiflora*), *Brachiaria brizantha*, a strongly creeping form of Makarikari *Panicum* from Tanganyika and a seeding form of Rompha (*Phalaris daviesi*) (*P. minor* × *tuberosa*).

Two one-acre plots—lucerne and chicory mixed with white and red clovers—were planted for irrigation but production was low as it is impossible at this stage to find enough water. Promising material for irrigation trials are *Trifolium johnstoni*, *T. semipilosum*, *T. repens* var. *latum* (Ladino clover) and several lucernes of which two creeping forms are of particular interest.

9. FERTILIZER EXPERIMENT ON PERMANENT PASTURE

This experiment is on a permanent mixed pasture of Star, Rhodes and Makarikari grasses sited on a very sandy soil containing only 7–11 per cent. silt and clay to a depth of 3 feet. It is designed to study, as a continuation of previous experiments, the long-term effects of sulphate of ammonia compared with other nitrogenous manures. That is, to determine whether the acidifying effect of sulphate of ammonia can be counteracted by the use of lime (and if limestone itself has any manurial value), whether the sulphur element of sulphate of ammonia is of importance and whether phosphate will in time prove essential for a dairy herd.

The first year's records have done little more than to establish the uniformity of the plots from soil and leaf samples and recorded yields. Owing to the poor nutrient status of the soil, significant responses were immediately observed to fertilizer application both in terms of yield and percentage crude protein as is shown in Tables V and VI below.

TABLE V
Fertilizer Experiment in Star Grass

Treatment				Dry weight grass produced per acre
Control	..	..	..	603
400 lb./acre sulphate of ammonia	..	..	..	1,722
400 + 845 lb./acre dolomite	..	..	..	1,349
800 lb./acre sulphate of ammonia	..	..	..	2,629
800 + 845 lb./acre dolomite	..	..	..	2,429
800 lb./acre nitramonical	..	..	..	1,865
800 + 1000 lb./acre gypsum	..	..	..	1,887
175 lb./acre urea (46 per cent.)	..	..	..	1,583
350 lb./acre urea	..	..	..	2,334
350 + 440 lb./acre single supers	..	..	..	2,104
350 + 175 lb./acre triple supers	..	..	..	2,807
350 + 100 lb./acre gypsum	..	..	..	2,303
L.S.D. P=0.05	..	..	..	817
Coeff. of Variation	..	..	..	28.8%

TABLE VI

Treatment	Before fertilizer applied		After fertilizer applied	
	Block II 2/6 per cent. protein	Block II 19/6 per cent. protein	Block IV 19/6 per cent. protein	
Control	6.9	7.8	7.3	
S/A 400	6.6	15.0	13.1	
S/A 400+dolomite	9.2	14.8	10.8	
S/A 800	7.3	13.6	15.6	
S/A 800+dolomite	8.7	13.6	17.6	
N/A 800	8.4	17.7	14.6	
N/A 800+gypsum	8.5	14.9	9.8	
Urea 175	6.3	11.5	13.5	
.. 350	6.9	14.0	13.0	
.. 350+400 supers	8.4	14.6	14.3	
.. 350+T. supers	6.6	13.1	14.8	
.. 350+1000 gypsum	8.3	17.6	14.6	

Nitramonical is again slower than sulphate of ammonia or urea containing equivalent amounts of nitrogen. In all the fertilized plots counts showed that the perennial grasses, mostly Star, were beginning to take over from annual grasses which, before fertilizer was applied, composed 50-70 per cent. of the green cover. The greatest response was obtained from 350 lb./acre urea with 175 lb./acre of triple superphosphate. Acknowledgment is made to Messrs. Tobacco Auctions, Limbe, for a gift of urea which helped to make this experiment possible.

Extract from Report of the Agricultural Chemist, Bvumbwe

PASTURES

FERTILIZER ON RHODES GRASS

In view of the possible effect the high nitrogen applications might have on other nutrients, various samples taken from the Rhodes Grass Experiment at Bvumbwe reported last year, were re-examined for P and K. Representative figures were:

TABLE VII

Month	Treatment	per cent.			
		N	Ash	P	K
December	Control	1.3	11.6	.56	.74
..	N/A 100/1	2.6	8.5	.59	1.23
March	Control	1.4	12.2	.55	1.13
..	N/A 100/1	1.9	9.6	.49	1.45
..	S/A 100/1	2.9	9.5	.29	1.34
August	Control	.8	12.1	.24	.48
..	N/A 100/1	1.2	8.6	.29	1.08
..	S/A 100/1	1.4	8.2	.22	.96
..	N/A 300/3	1.1	9.1	.35	.90
..	S/A 300/3	1.6	9.9	.28	1.17

It appears therefore that the nitrogen applications increase the potash uptake—although not having such a great effect on the phosphate. From the seasonal variation it appears that the potash and phosphate uptake is related to rainfall or moisture content of the soil.

HYDROCYANIC ACID IN STAR GRASS

New flush of Star grass was examined for hydrocyanic acid content, the figures being as follows:

				Moisture per cent.	Hydrocyanic acid p.p.m.		On basis of orig. green state
					as examined	on dry wt. basis	
Green leaf	..	..	..	80	330	1,650	330
Wilted 1 day	..	..	..	65	478	1,370	274
.. 3 days	..	..	..	30	619	885	177
.. 1 week	..	..	..	25	168	224	45

These figures are similar to those obtained in 1956, although the fuller examination of the wilting time factor indicates that though there is a loss of HCN on wilting, the greater loss of moisture in three days means that there is an effective increase in hydrocyanic acid per lb. of grass ingested.

Extract from Report of the Agricultural Chemist, Chitedze

THE FEEDING VALUE OF NATURAL BUSH GRASSES

Mixed samples of these grasses consisting largely of *Hyparrhenia* species, together with species of *Rottboellia*, *Setaria* and *Digitaria* were submitted at regular intervals throughout the year in order to study variations in feeding value. The results of these analyses are given in Table VIII.

TABLE VIII
The Feeding Value of Natural Bush (Tengo) Grasses

Lab. No.	Date			per cent. Moisture	Ash	Crude Protein	Crude Fibre	P ₂ O ₅
412	30/	1/58	.. ..	80.9	10.7	8.31	31.42	0.44
438	3/	3/58	.. ..	72.7	11.7	9.08	28.20	0.50
525	29/	3/58	.. ..	35.7	8.7	7.71	31.33	0.36
529	1/	5/58	.. ..	51.0	6.3	6.18	33.37	0.28
542	2/	6/58	.. ..	48.0	7.2	2.70	36.57	0.14
597	30/	6/58	.. ..	32.5	7.2	2.81	37.46	0.12
671	29/	7/58	.. ..	11.8	6.6	2.31	37.80	0.12
699	21/	10/58	.. ..	15.9	8.8	3.06	35.73	0.15

The results show that while the food value is high during the wet season it falls off very rapidly with the end of the rains reaching a much lower level than many of the improved grass species, such as the *Cenchruses*, *Panicums* and the leafy strains of *Cynodon* where the crude protein content remains at 5 per cent. and over, well into the dry season.

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Departmental Non-Resident Staff Partially Concerned with Tea Experimental Work

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<i>Soil Physics</i>	..	..	R. A. WOOD, B.SC.
<i>Laboratory Technician</i>	..	..	R. C. PEAK

Leave

<i>Tea Research Officer</i>	..	..	U.K., August/October, 1957.
<i>Principal Agricultural Supervisor</i>	..	..	U.K./South Africa, December/June, 1957/58.

Transfer

As from 31st July, 1958, Mr. D. L. Downie, Senior Tea Research Officer, proceeded on U.K. leave pending transfer to the West African Institute for Oil Palm Research.

Acknowledgements

Messrs. Bishop, Hey, Thompson and Westrop have throughout the season placed tea and labour at our disposal for estate experiments. We wish to thank them all for the trouble and time that they have given on our behalf.

During the past two years work has been developed requiring electrical apparatus, some of it orthodox and some from original designs. Considerable help has been given readily and cheerfully by Mr. S. J. Scott, Telephone Inspector, Mlanje, in the design, fault finding and in the repair of these pieces of apparatus. We wish here to offer him our very grateful thanks.

INTRODUCTION

Unless otherwise stated the results in this Report refer to the crop season July, 1957, to June, 1958.

This season will long be remembered as the year of the drought; rainfall for the dry season was tragically low and exceedingly badly distributed. At Swazi for example, only 4.79 inches of rain were recorded from May to the end of November, 1957, a deficit of 13.50 inches against the long term average. During that period rain was recorded on only 24 days, there being 190 rainless days, and in this time there were two rainless periods of no less than 36 and 49 consecutive days. Temperatures as a result were abnormally high. The main effect was on young tea, two to ten years old, which suffered as a rule from 25 to 35 per cent. deaths. Newly planted tea and mature tea, although badly wilted and completely unproductive, did not die so readily. For example at Mimosa which carries no tea older than eight years, overall deaths were in the region of 25 per cent. At Swazi on the other hand where all tea is over ten years old and mostly over twenty, the total number of dead plants removed from 35 acres of 4 feet square spaced tea, with approximately two-thirds of the area unpruned, was only 12.

Cropping began about a month later than usual because of the late rains and so continued throughout the season. In general the outturn from mature tea was in the region of the long term average—a remarkable recovery after a slow start.

No new major field experiments were started during the season and efforts were concentrated on the planned programme. The rate of progress dropped inevitably as a result of abnormally concentrated leave requirements. Throughout, labour was adequate for experimental and other purposes.

Towards the end of the season great strides were made in starting the sub-station at Cholo. Through the generosity of Mr. Rolfe Gardner of Nchima Estates, Cholo, 150 acres of land have been made available and are ideally suited to our purposes. Funds were approved and opening up started on 1st July, 1958. It is intended to develop the station using advanced soil conservation practices and land usage principles to demarcate and align the fields. Present plans are that the Shade Trees times N.P.K. experiment will be planted in 1959/60 (ringbarking being satisfactory) and to follow this with one replication of the Complex Experiment, a comparison of customary tea planting against a system based on sound principles of water and soil conservation, and to try under Cholo conditions vegetative propagation methods and material produced by the plant improvement programme.

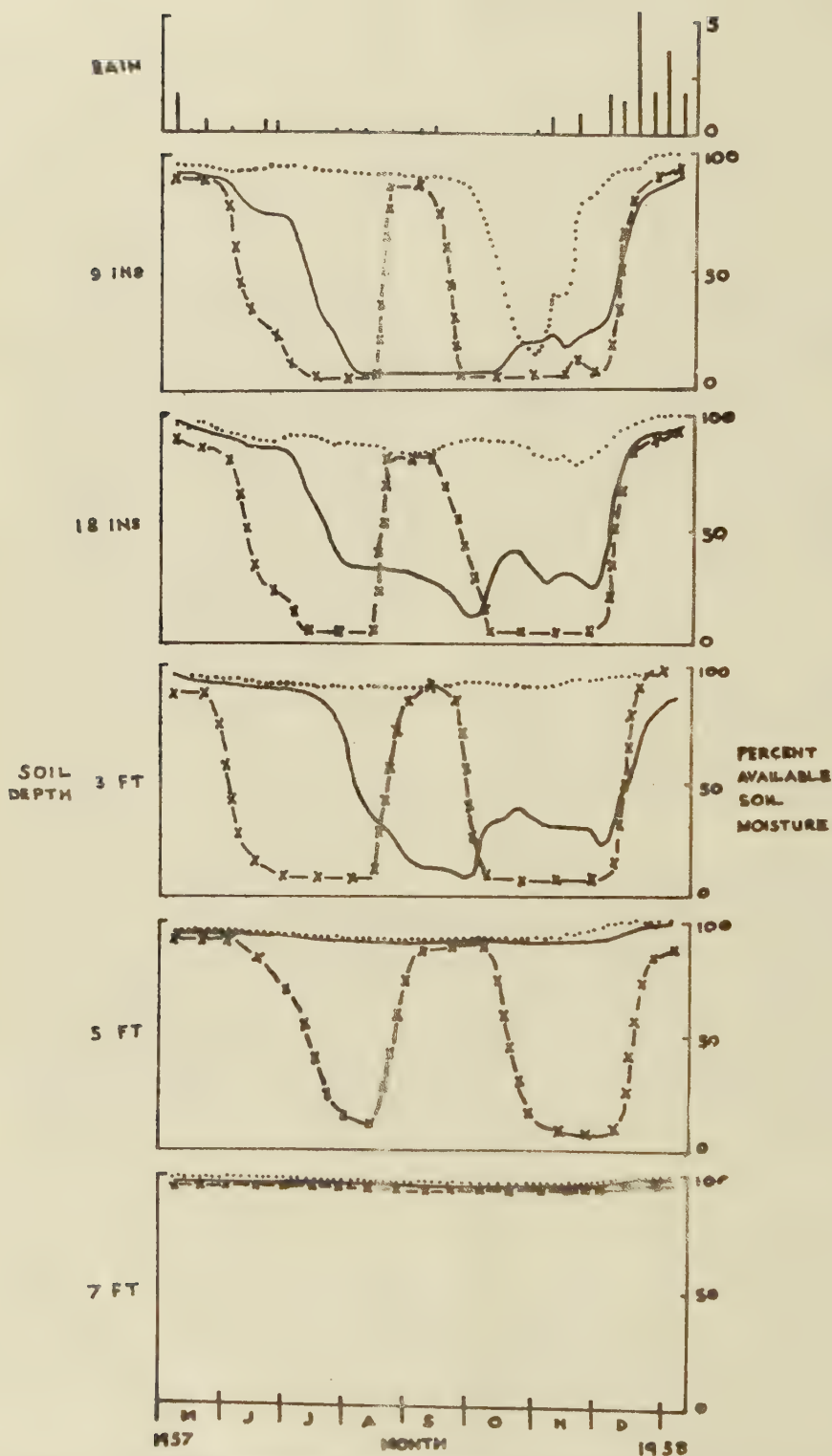


FIGURE 1. Soil moisture movements under nurseries of various ages. See text.
Seedling age in months: 0-6 , 12-18 ——— , 24-30 x ——— x

NURSERY EXPERIMENTS

Soil Moisture

In paragraph 10 of the 1956/57 Report it was stated that as a preliminary observation before laying down new nursery experiments, recordings would be made on soil moisture movements under nursery beds. The results taken at Mimosa during the past season are given graphically in Figure 1. There were three seedling ages compared and replicated gypsum soil moisture testing blocks were sunk under each age group at the following depths; 9 inches, 18 inches, 3 feet, 5 feet and 7 feet. All seedlings were spaced at 6 inches square.

(a) Seedlings which were approximately 6 months old at December, 1957. These were under the high 6 foot orthodox nursery shade and were not watered throughout the period. (Dotted line on the graph.)

(b) Seedlings which were approximately 18 months old at December, 1957, shaded as above and were, against intention, accidentally half-watered during November. (Full line on graph.)

(c) Seedlings which were approximately 30 months old at December, 1957, which would normally be cut back to provide "30 month" old stumps for transplanting. These had no overhead shade and the beds were deliberately and thoroughly soaked during late August so that a second drying curve could be recorded. (Lines between crosses on graph.)

The spacing and shading of these nurseries was according to usual practice although watering was not—the object being to obtain a series of complete drying curves. The beds for all ages of seedlings were adjacent and on one contour so as to overcome soil irregularities as much as possible.

Little moisture was used by the youngest seedlings until October and then the top 9 inches of soil was dried to near wilting point. Slight but obvious drying was seen at the same time at the 18 inch depth and little drying below. These curves indicate that watering requirements for seedlings during their first dry season after planting are not high and it is perhaps possible that overwatering takes place under present estate methods.

With the next older seedlings, rapid drying commenced at the end of May and moisture reserves reached wilting point in the top 9 inches about eight weeks later. From the commencement of drying all soil depths down to 3 feet were at wilting point by the end of September some 17 weeks later. Virtually no drying occurred at 5 feet and 7 feet.

In the case of the 30-month-old unshaded seedlings drying was rapid and nearly simultaneous in all depths down to 5 feet and this depth agrees well with the root dissections recorded in paragraph 5 of last year's report. A similar rapid drying curve can be noted during October and November after the beds had been watered.

Although the point at which vigorous growth is first checked in tea seedlings is not known, judging from the literature it might turn out to be approximately 50 per cent. of available moisture. The rapidity with which this figure is reached starting with a fully wet soil will depend upon meteorological conditions and these were abnormally intense last season. The 50 per cent. point was reached under the 18- and 30-month-old seedlings, at all depths, in two or three weeks after drying commenced.

These recordings, although fundamentally complicated and taken under adverse climatic conditions, have indicated two points for nursery watering experiments. Firstly, and contrary to established practice, it is the older seedlings that appear to require progressively more watering than the younger, and the youngest in fact would

appear to require little more than infrequent watering. Secondly and quite unsuspected is the rapidity with which the older seedlings dry the soil—particularly 30-month unshaded ones. It follows therefore that consideration might be given in practice to watering these nurseries heavily at regular intervals of not longer than two or three weeks, immediately the main rains have stopped, and not to wait, as more often than not is done, until wilt symptoms develop in September or later. Tea does not show wilting symptoms with its mature leaves until a considerable time after deleterious effects have occurred below ground.

Although not directly connected with these soil moisture observations, after the drought, another important factor came to light which adds support to a change-over in practice being necessary from the usual method of leaving 30-month nurseries unwatered throughout their last dry season ("survival of the fittest"). Wherever badly wilted and defoliated nurseries were examined shortly after the drought it was found that the root systems were poor in, or devoid of, starch, which had presumably been used up in the struggle for survival. The newly planted stump is dependent upon starch for survival immediately after transplanting in the field and to transplant stump low in starch because of previous moisture stress is to court disaster thereafter.

It follows that provision and equipment for watering nurseries should be adequate and ready at the end of the rains and not in mid-dry season, as is all too frequently found at present.

Survival of Young Tea

(i) COMPLEX EXPERIMENTS

These experiments, to be described in more detail later, were severely affected by the drought as can be seen in Table I which records the percentages of deaths for the season. Previously these experiments carried not less than 98.5 per cent. of their allotted numbers of bushes.

TABLE I
Percentages of Deaths according to Spacing and Age after Planting

Replication	Age	Spacing			L.S.D.	
		4' × 4'	4' × 3'	4'(2' × 2')	0.05	0.01
		plants p.a.	2720	3630	7260	
First	3 years	15.2	21.2	38.9	2.7	3.6
Second	4 years	18.7	21.0	29.6	5.2	7.0
Third	5 years	28.9	31.8	37.7	3.9	5.3

Replication		1957/58		1956/57	
C.V.%	First	..	20.31	..	10.30
	Second	..	41.03	..	9.22
	Third	..	19.66	..	6.46

Increasing the numbers of plants per acre resulted in proportionately more deaths and in terms of absolute numbers of plants as opposed to percentages, there is a very close and highly significant linear relationship between numbers of deaths and the original numbers of plants per acre at each age. The increase in the standard errors of the experiment are obvious and their future must now be a matter of doubt. Increasing nitrogen rates (*see* page 91 of this Report), a second treatment series examined in these experiments, gave significantly lesser deaths in only one out of the three experiments and must therefore be regarded as of doubtful importance.

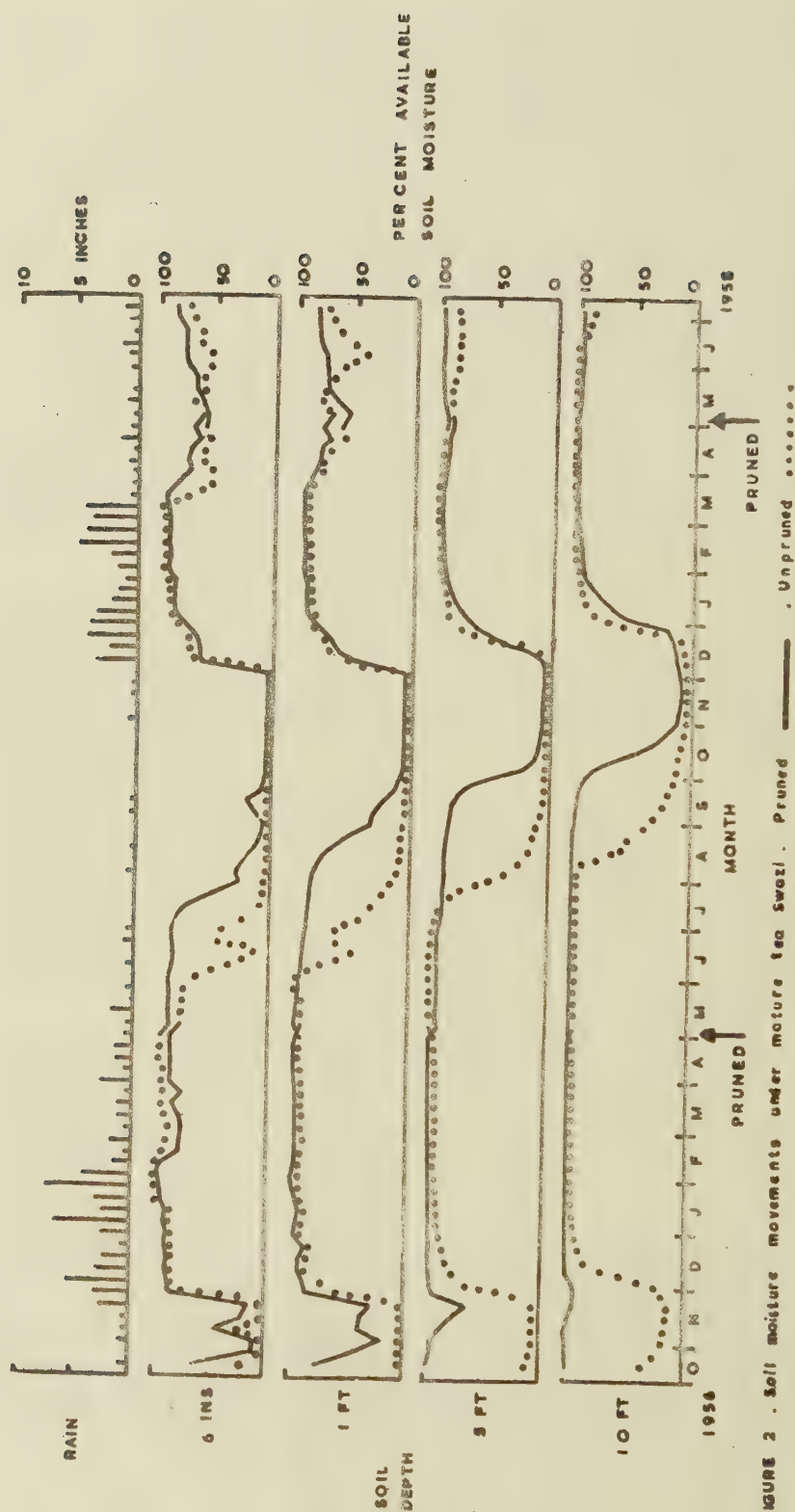


FIGURE 2 . Soil moisture movements under mature tea Swazl. Pruned — . Unpruned

(ii) FOUR SPACINGS AND FOUR NITROGEN RATES, MIMOSA

This experiment will be described in more detail in later sections of this Report. There are three complete replications forming the whole experiment and from May, 1957, a three-year pruning cycle was started; clean prune, unpruned, cut-across.

In order to phase pruning effects over seasons one replication was entirely clean pruned, the second left unpruned and the third cut-across removing approximately half of the top hamper. Thereafter the pruning sequence for each replication will progress in sequence according to the cycle. Disregarding detailed spacing or nitrogen treatments, each replication as a whole is directly comparable in the total numbers of plants at each and any spacing and the total amount of nitrogen added. Percentage deaths according to pruning treatment were:

Clean pruned	..	..	..	..	5.90
Cut-across	..	..	..	..	13.82
Unpruned	..	..	..	..	31.27

The tea was six years old at December, 1957. Complete removal of leaf by clean pruning obviously offered considerable protection and partial removal by cut-across pruning was better than no prune.

As with the Complex Experiments the numbers of deaths per acre are closely related to the original numbers of plants. Increasing nitrogen rates offered no significant protection.

(iii) THE EFFECT OF N, P AND K ON SURVIVAL, MIMOSA

In an experiment comparing applications of nitrogen, phosphate or potash on four-year-old tea (*see* page 89 for rates) no significant effects on survival were obtained from the fertilizer applications.

(iv) THE EFFECT OF SHADE TREES ON SURVIVAL, MIMOSA

Three species of shade trees and no shaded tea, combined with nitrogen, phosphate and potash dressings are compared in this experiment on six-year-old tea. No treatment had any significant effect on the percentages of deaths over the past season—the tea being clean pruned before the onset of the drought.

Soil Moisture Studies

(i) SOIL MOISTURE MOVEMENTS UNDER MATURE TEA, SWAZI

Measurements of available soil moisture under mature tea using gypsum blocks and a resistance meter were continued at Swazi during 1957/58. Measurements are taken at depths below soil surface of 6 inches, 1, 2, 3, 4, 5, 6, 8 and 10 feet under a series of plots half of which are pruned in alternate years at the end of April or in early May. Data for two consecutive seasons at representative depths are presented graphically in Figure 2.

On the graphs the full line represents moisture movements under the tea which is pruned and therefore is leafless throughout May. Thereafter it gradually forms new shoots which are tipped at 8 inches above the pruning cut. After prune an increasing amount of foliage is being formed and by November at the end of the dry season, a nearly complete canopy of leaf covers most of the soil below.

The unpruned plots, dotted line, carry a completely undisturbed leaf canopy throughout the dry season.

Recordings started in mid-October, 1956, at which time most of the soil volume under the unpruned plots had dried to near wilting point although some available moisture still remained at 10 feet. At the same time considerable moisture conservation can be seen under the pruned plots. During November, 1956, and until the break of the rains, drying took place slowly under the pruned plots and also at the 10 foot depth under the unpruned treatment. The rains rapidly filled both soil profiles and with minor fluctuations mainly in the top 6 inches, the soils remained filled until about half-way through May, 1957. Thereafter the drought set in and under the unpruned tea the entire profile down to the maximum recorded depth of 10 feet was dried to wilting point between late July and the end of October depending on depth. Meanwhile pruning, as expected, conserved the moisture for about two months but, in distinct contrast to the previous year, the entire profile down to 10 feet was eventually dried to wilting point for a considerable length of time before the new rains. Table II records the approximate length of time at which the various depths remained at wilting point before refilling with the new rains.

Table II

Approximate Times at which Various Soil Depths remained at Wilting point Under Pruned and Unpruned Mature Tea

Soil depth	Unpruned	Pruned
6"	4.5 months	4.0 months
1'	4.0 "	2.0 "
5'	3.5 "	2.0 "
10'	3.0 "	1.5 "

No comparative data is available for 1956 because recording did not start until mid-October but it can be seen that under the unpruned tea the soil at 10 feet did not remain near wilting point for more than one month and under the pruned tea the 5 and 10 foot depths had not approached wilting point before the onset of the rains. A contrasting picture to 1957.

The 1957/58 rains were about a month later in starting than average and the profile was not filled until near the end of January, 1958. In the preceding year the profile was filled by mid-December, some six weeks earlier in the growing season.

The rains were particularly poor in early April, 1958, and at pruning time the moisture picture was approximately equal to that in mid-June of the previous year—some six weeks ahead. Fortunately useful quantities of rain fell thereafter until the end of June and these rain days were accompanied by mist, low temperatures and very cloudy skies which aided soil moisture conservation. By the end of June, 1958, the picture had considerably recovered from the alarming one seen at the end of April.

For two seasons now pruning has, as expected on theoretical grounds, caused moisture conservation but it must be borne in mind that this tea is mature and well established. It would be incorrect to conclude thereby that annual pruning for **mature** tea is necessarily the correct procedure. Long term yields from pruning experiments show that no advantage is to be gained from annual pruning (see page 10 below).

(ii) SOIL MOISTURE MOVEMENTS UNDER THE COVER CROP *STYLOSANTHES GRACILIS*

Gypsum soil moisture blocks were sunk under plots of young tea interplanted with or without the cover crop, *Stylosanthes gracilis*. The tea was clean pruned at the start of the observations in May, 1957. Soil moisture recordings using gypsum

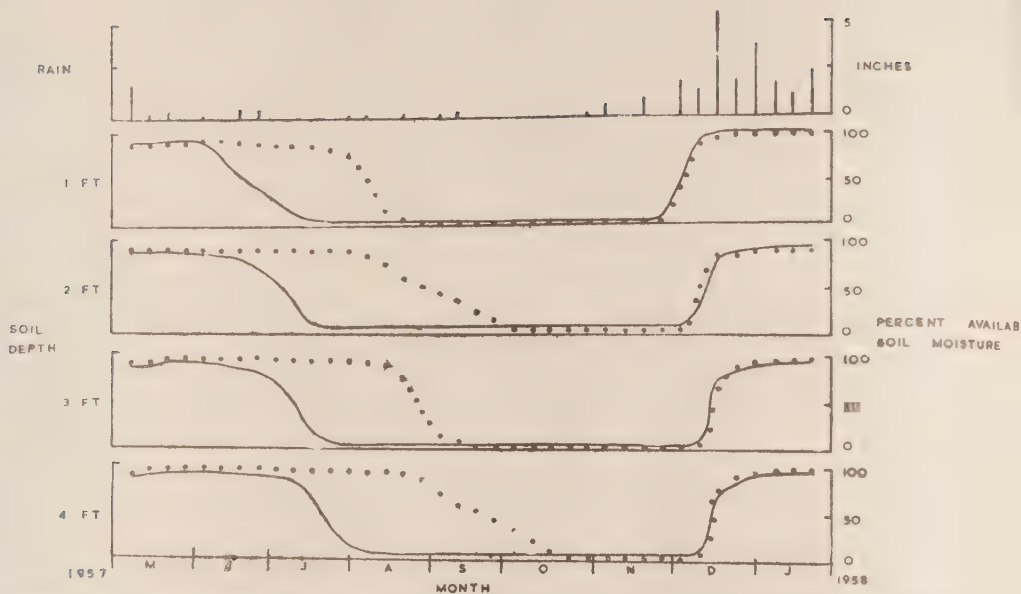


FIGURE 2 Soil moisture movements under young tea with and without the cover crop *STYLOSANTHES GRACILIS*
 With STYLO ——— , Without cover crop

blocks were taken at 1, 2, 3 and 4 feet below ground level and the results are given graphically in Figure 3. The full lines on the graph are from plots with *Stylosanthes* and the dotted lines from clean weeded plots without cover crop.

Under the cover crop drying started about two months earlier than in the clean weeded plots and as the tea was clean pruned shortly before the beginning of recordings it must be assumed that most of the early drying was caused by the cover crop and not by the tea or the direct action of the climate on the soil itself. The soil under the cover crop was at wilting point for about four-and-a-half months in the surface layers and four months in the deepest layer. Without a cover crop the surface layers were at wilting point for about three months and the deepest layers for two months. Both series filled with the onset of the December rains.

It is perhaps this unequal competition for soil moisture which accounts for most of the deleterious effects obtained from cover crops in Nyasaland (*Helopeltis* damage being disregarded). Even young tea by itself is seen to dry the soil out to wilting point in at least the top 4 feet of soil and therefore to add further competition from cover crop roots (or weeds) would seem to be foolish. In lieu of a satisfactory cover crop the policy of not interplanting tea must still be recommended.

(iii) SOIL MOISTURE MOVEMENTS UNDER SHADE TREES

The original blocks sunk under a few of each of the shade trees in the shades times fertilizer experiment did not prove satisfactory and in May, 1958, blocks were sunk at 1, 5 and 10 feet depths in each of the 64 sub-plots of the experiment. These should therefore offer sound comparisons between shade species, and between fertilizers and between possible interactions of shade and fertilizer.

(iv) SOIL PHYSICS

The above experiments have been illustrated by using the simple "percentage available soil moisture" scale on the Bouykos Meter. The Agricultural Chemist, Chitedze, is exploring the soil constants in terms of inches of water and reference should be made to the relevant sections of his report (Annual Report of Department of Agriculture, Part II) on soil physics for more detail.

Pruning Experiments

(i) LENGTH OF PRUNING CYCLE AND TYPES OF PRUNE, SWAZI

This experiment completed its second year of the three year cycle and will be reported in detail next year at the end of the cycle.

(ii) PRUNING CYCLES ON LOCAL JAT TEA, THORNWOOD ESTATE

One set of treatments in this experiment compares annual, biennial and triennial clean pruning cycles and in May, 1958, all plots had completed six years of treatments and were therefore clean pruned. Yields for the past season and for the full six years are recorded in Table III. The total yields for the six years have been averaged.

TABLE III
Yields in lb. m.t.p.a. according to Pruning Cycles, Thornwood Estate

Cycle	Yearly	2-yearly	3-yearly	L.S.D.	
				0.05	0.01
1957/58 season	893	802	706	98	134
Average per year for 6 years	1,073	1,039	1,040	none	none

C.V.% 1957/58, 17.74% ; C.V.% 6 seasons is 14.84%

For the past season, and at $P=0.05$, the annually pruned plots just failed to yield significantly more than the two-yearly plots (unpruned during the season) and

the latter just failed to yield significantly more than the three-yearly plots which were in their third and last year from prune. The annual cycle yielded significantly more than the three year cycle at $P=0.01$.

The design of this experiment would have been improved if it had been possible to phase the pruning so that each year all stages of all pruning cycles were represented. This would have had the effect of eliminating bias due to climatic effects. Drought in 1957 adversely affected the two and three year cycles in relation to the yearly prune but in spite of this bias there is no significant difference between the three treatments. But this is not the complete picture and the average yields as shown in Table III do in fact hide a recently significant interaction between cycle and nitrogen rate, the latter being a second set of treatments in this experiment. These are equivalent to annual application of 40, 80 and 120 lb. of nitrogen (N) per acre in the form of sulphate of ammonia—phosphate and potash dressings being equalized over all plots. The interaction has been slowly building up for the past three seasons and the linear $\times$ linear component reached significance this season at $P=0.05$.

In Table IV yields are classified according to pruning cycle and nitrogen rate and are, as in Table III, average yearly yields for the six seasons.

TABLE IV

Average Yearly Yield for 6 years in lb. m.t.p.a. according to Nitrogen Rate and Pruning Cycle

<i>Pruning Cycle</i>				<i>Nitrogen rate, lb. N.p.a.</i>		
				40	80	120
Yearly ..	..	..	..	867	1,053	1,298
Two yearly	..	..	..	788	1,029	1,299
Three yearly	..	..	..	726	1,056	1,337

It is now appearing that low nitrogen is not proving sufficient to maintain extended cycles at their optimum rates and that crop is being lost thereby. These losses are not apparent in the average yields according to length of pruning cycle alone given in Table III.

Tipping Experiments

(i) HEIGHT OF TIPPING INDIAN JAT TEA, SWAZI

This experiment was in its second year from prune and there are no significant residual effects on yield from tipping at 4, 6 or 8 inches above the pruning cut in the previous year.

(ii) TIPPING LOCAL JAT TEA, THORNWOOD ESTATE

Tipping at 2, 4 and 6 inches above the prune was only operative on the annually pruned plots of the three cycles compared and described above (page 87). As is usual significant differences in yield were only produced during the tipping phase—this season extended to the end of December instead of November because of the drought—and thereafter no significant differences appear in whole season yields. No significant differences due to tipping height have accrued over the six seasons.

Fertilizer Experiments

This section deals only with fertilizers applied to unshaded tea planted at one spacing in any one experiment. The interplay of fertilizers with other management methods is reported in other sections. Unless otherwise stated, experiments comparing the effect of only one of the major nutrients have the other two fertilizers equalized over all plots.

(i) N.P.K. EXPERIMENT ON YOUNG INDIAN TEA, MIMOSA

This experiment was planted at Mimosa in December, 1953, and is comparing the effects of the three standard nutrients on the yields and development of young tea. The fertilizers used are sulphate of ammonia, superphosphate and muriate of potash, and sulphur is added as necessary in the form of flowers of sulphur to each treatment combination so that each plot receives equal total quantities of sulphur. Table V summarizes the nutrients added to date.

TABLE V
Nutrient Rates according to age lb. per acre of N; P₂O₅ or K₂O

Date applied	Nutrient lb. p.a.					
	n ₀	n ₁	P ₀	P ₁	k ₀	k ₁
December, 1953	—	—	Tea planted		—	—
June, 1954	10	20	nil	10	nil	10
December, 1954	15	30	nil	10	nil	10
November, 1955	20	40	nil	15	nil	15
November, 1956	25	50	nil	20	nil	20
November, 1957	30	60	nil	25	nil	25

There have been no significant differences produced in yields either during the past season or in previous seasons. 1957/58 yields are given in Table VI and are approximately half those of the previous season due to drought effects.

TABLE VI
Yields in lb. m.t.p.a. according to Fertilizer Treatments on Young Indian Tea

Nutrient	Nitrogen		Phosphate		Potash	
Season	n ₀	n ₁	P ₀	P ₁	k ₀	k ₁
1957/58	322	307	303	326	310	319
Total yield for 1955/58	1,205	1,222	1,186	1,241	1,220	1,207

C.V.% 1957/58, 14.50% ; 1956/57, 5.45%.

(ii) SULPHATE OF AMMONIA AT FOUR RATES ON TWELVE YEAR OLD TEA, SWAZI

In accordance with the plan of concluding secondary long term experiments at Swazi in preparation for the eventual move to Mimosa of senior scientific staff, this experiment finished in June, 1957. In summary, it has shown that immature tea cannot efficiently use large quantities of nitrogen and that sulphur is possibly the effective nutrient during the first five years after planting. The results have been used in formulating the recently issued pamphlet on Fertilizer Policy.

(iii) SULPHATE OF AMMONIA AT FOUR RATES ON MATURE INDIAN TEA, SWAZI

Similarly this experiment was concluded at June, 1957, when the tea was approaching its twenty-fifth year. It has during its long run demonstrated linear responses to nitrogen up to 70 lb. N. per acre the highest rate consistently used and, during its last three seasons, rapid recovery in yield, when the previous no-fertilizer control plots received nitrogen at the rate of 120 lb. N. per acre.

For ten years the control plots were without any fertilizer and at the end of this period their yields were in the region of 200 lb. of made tea per acre. Yet no visual symptoms of sulphur deficiency were apparent. It appears possible therefore that severe " yellows " symptoms are associated with very young tea with a root system exploring only a small soil volume and that with mature tea an extensive root system extracts at least sufficient sulphur to avoid visual damage to plant tissues.

In its last nine seasons the experiment has yielded an overall average of 5.2 lb. of made tea for each pound of nitrogen added (5 lb. S/Amm.) between totals of 35 and 70 lb. nitrogen per acre. This average excludes the 1948/49 drought year when the main rains failed during mid-crop season and this calamity following an unusually late prune caused poor recovery and considerable sun scorch. The return that season was quite abnormally low and stood at only 0.7 lb. of made tea for each pound of nitrogen.

(iv) THREE-CUBED FACTORIAL N.P.K. ON MATURE INDIAN TEA, SWAZI (MLANJE DISTRICT)

This experiment received its seventh consecutive set of treatments during the past season and compares the effects of the three standard fertilizers (without additional sulphur) on poor unshaded Indian type tea, spaced at 4 feet square.

Yields for the past season are given in Table VII.

TABLE VII
Effect of N.P.K. on Yields at Swazi; yields in lb. m.t.p.a.

Nutrient	N			P ₂ O ₅			K ₂ O		
lb. per acre	40	80	120	0	30	60	0	30	60
Yield m.t.p.a.	661	913	1,164	899	897	942	904	930	904
L.S.D.	P=0.001=185			none			none		

C.V.% 1957/58, 13.07% ; 1956/57, 11.35%

The differences due to each upward step in nitrogen are linear and are significant at P=0.001. From N40 to N80 the return in made tea for each pound of added nitrogen was 6.30 lb. and from N80 to N120, 6.28 lb. of tea.

The differences due to phosphate or potash applications are not significant.

(v) THREE-CUBED FACTORIAL N.P.K. ON NAMIREME ESTATE (CHOLO DISTRICT)

The fertilizer treatments on this Cholo experiment are replicas of those at Swazi and fertilizers were applied in the same week as those at Swazi. The tea at the start of the season was given a light cut-across prune to remove excessive top hamper and it is clean pruned on a two year cycle. It was therefore during the season in its last year before clean prune. Yields for the season are given in Table VIII.

TABLE VIII
Effect of N.P.K. on Yields at Namireme Estate; yields in lb. m.t.p.a.

Nutrient	N			P ₂ O ₅			K ₂ O		
lb. per acre	40	80	120	0	30	60	0	30	60
Yield m.t.p.a.	248	357	450	355	362	338	343	360	352
L.S.D.	P=0.001=90			none			none		

C.V.% 1957/58, 16.52% ; 1956/57, 15.96%.

Each upward step in nitrogen rate has caused highly significant increases in yield; there being no significant differences due to phosphate or potash. The return in tea for each pound of added nitrogen from N40 to N80 is 2.73 lb. and from N80 to N120, 2.33 lb.

(vi) SULPHATE OF AMMONIA ON LOCAL JAT TEA, THORNWOOD ESTATE (MLANJE DISTRICT)

The effect of pruning cycles and tipping heights in this experiment have been given earlier and it remains to discuss the effects of nitrogen applied at the equivalent of 40, 80 and 120 lb. N. per acre as sulphate of ammonia. Yields for the past season are given in Table IX.

TABLE IX
Effects on Yields of Increasing Nitrogen Rates, Thornwood Estate

<i>lb. N.p.a.</i>	40	80	120	L.S.D.
Yield m.t.p.a. ..	519	795	1,087	P=0.001=180

C.V. % 1957/58, 17.74%

Each upward step in nitrogen has yielded highly significant and linear increases in crop. The return in lb. made tea for each pound of nitrogen applied from N40 to N80 is 6.91 and from N80 to N120, 7.32 lb.

During the past season the annually pruned plots were clean pruned and the two and three yearly cycles were each in their last year before prune and hence unpruned. The increased efficiency of nitrogen in unpruned years can be seen in Table X wherein detailed returns per lb. of added nitrogen are recorded against pruning state.

TABLE X
Returns in lb. m.t.p.a. from each lb. of added N. in Relationship to Pruning

<i>Pruning</i>	<i>From N40 to N80</i>	<i>From N80 to N120</i>	<i>Mean</i>
Newly pruned	5.25	4.93	5.09
2 years from prune.. ..	6.02	6.75	6.39
3 years from prune.. ..	9.03	8.10	8.57

In page 88 above, reference has already been made to the linear $\times$ linear part of the nitrogen rate and pruning cycle interaction reaching significance at $P=0.05$ this season. This component accounts for 85 per cent. of the total sums of squares for the interaction.

The failure of low nitrogen rates in supporting extended cycles during the past season can be clearly seen in Table XI.

TABLE XI
Yields in lb. m.t.p.a. according to Pruning Cycle and Nitrogen Rate

<i>Pruning Cycle</i>	<i>Nitrogen rate lb. N.p.a.</i>		
	40	80	120
Yearly	688	898	1,095
Two yearly	511	769	1,126
Three yearly	357	718	1,042

(vii) TWO-CUBED N.P.K. AT LAUDERDALE ESTATE (MLANJE DISTRICT)

In support of the soil survey carried out by the Agricultural Chemist, Bvumbwe, a uniformity trial for a simple diagnostic N.P.K. experiment was carried out at Lauderdale Estate, Mlanje, in the season 1956/57 where it was suspected a response might be obtained to potash. The three standard fertilizers were applied at the rates

detailed below in November, 1957, and yield recordings were taken at approximately every second plucking round. Other commitments prevented a strict adherence to the alternate recording at times, but previous investigation has shown that sample recording at every second or third round is a reliable procedure. The plots were not yielding uniformly before fertilizers were applied and this season's yields have accordingly been adjusted on uniformity yields. Yields in Table XII are plot totals of made tea—it being unwise after sample recording to transform the data into made tea per acre for the purposes of calculating responses.

TABLE XII
Effect of N.P.K. on yields at Lauderdale Estate, Mlanje District
Weights are plot yields in lb. made tea

<i>lb. per acre</i>					<i>Nutrient</i>					
					N		P ₂ O ₅		K ₂ O	
					0	80	0	60	0	60
Yield m.t.	..	..	..	..	163	186	178	171	175	174
Significance	..	..	..	..	P=0.01		none		none	

In spite of expectation only nitrogen has caused a significant difference in crop and this difference is very reliable at $P=0.01$.

(viii) SIMPLE TWO-CUBED N.P.K. AT BANDANGA ESTATE (CHOLO DISTRICT)

An exactly similar experiment to the Lauderdale one was laid down two seasons ago on Bandanga Estate on some of the first (widely spaced) local tea to be planted in Cholo. It was suspected at the time that this area might also be suffering from a potash shortage.

Fertilizers were applied in November, 1956, and 1957 and yields in lb. made tea per acre to date are given in Table XIII.

TABLE XIII
Effect of N.P.K. on Yields at Bandanga Estate, Cholo District

<i>lb. per acre</i>					<i>Nutrient</i>					
					N		P ₂ O ₅		K ₂ O	
					0	80	0	60	0	60
lb. m.t.p.a. 1956/57	..	..	..	..	457	592	529	520	520	529
lb. m.t.p.a. 1957/58	..	..	..	..	304	485	394	395	377	412
									101	163
									103	165

C.V.% 1957/58, 14.05%; 1956/57, 10.40%.

In the first season of fertilizer application, 1956/57, nitrogen caused a significant difference in crop at $P=0.01$ and in the second season this difference widened to reach significance at $P=0.001$. The return in made tea for each pound of added nitrogen reached 2.26 lb. this season, compared with an average of 2.53 lb. at Namireme Estate.

The difference due to phosphate and potash do not reach significance.

(ix) NITROGEN RESPONSES BETWEEN MLANJE AND CHOLO

In these experiments on unshaded tea, planted in the region of 4 by 4 feet square, the returns from nitrogen have differed widely between the two districts during this and previous seasons. In Mlanje the return this season has been in the region of 6 to 6½ lb. of tea for each pound of added nitrogen and in Cholo between 2 and 2½ lb. of tea. Although the Cholo evidence is not nearly so extensive as that from Mlanje (a position which should be slowly rectified now that the Cholo sub-station has started) the little evidence that there is, is beginning to show that in Lower Cholo responses to nitrogen are considerably less than those obtained in Mlanje. The reasons are not yet clear but it appears rather strongly that the lower rainfall of these Cholo areas might be an important factor.

In spite of these lower returns the responses obtained up to 120 lb. of nitrogen per acre are still linear and economically worth while. Five pounds of sulphate of ammonia cost about 1s 5d when applied to the tea and the profit therefrom should be in the region of two shillings; representing an interest of some 40 per cent. on the capital outlay.

Time of Fertilizer Application

Following the policy of closing down non-essential Swazi experiments in preparation for the move over to Mimosa three experiments have been discontinued. Those compared various times of applying fertilizers throughout the year and over the years they have indicated that optimum efficiency is obtained from applications given just before the main rains. Should an unmanageable burst of crop be expected as a result of a full dressing at that time, then the next most efficient way is to divide it between early November and the first full banjhi period of the main rains, which usually occurs in January.

Weedkillers

FORMAL EXPERIMENT, MIMOSA

In an attempt to check early season weed growth for the time when it is usually most vigorous and labour chronically short, an experiment has started at Mimosa comparing the effects of the following treatments on tea from planting until such time as it forms a sufficiently dense top hamper to suppress effectively weed growth to non-serious dimensions:

- (a) Plots kept clean weeded at all times by light surface scraping with a hoe.
- (b) Plots clean weeded before the onset of the rains and then left unweeded until the end of January. Thereafter clean weeded by hoe. This treatment approximates to estate conditions during the early crop season.
- (c) Plots clean weeded before the onset of the rains and then weed and grass growth sprayed, when about an inch high, with T.C.A. at 15 lb. per acre plus sodium chlorate at 33 lb. per acre. Thereafter hand weeded by hoe as necessary until the following rains.
- (d) Basically as for (c) but sprayed instead with T.C.A. at 15 lb. per acre plus M.C.P.A. at 0.5 acid equivalent per acre.
- (e) Basically as for (c) but sprayed instead with T.C.A. at 15 lb. per acre plus 2.4D at 0.5 acid equivalent per acre.

The plots were planted to tea in December, 1957, and then treated according to plan. No measurements have yet been made on the tea either for survival or for growth. All weed killer combinations had the desired effect in controlling weed growth for at least six weeks.

Estates will be well advised to wait some concrete results from this experiment before trying weed killers on their tea as the long term effects are not yet known.

Spacing of Tea

(i) GENERAL

All the spacing experiments described below are with tea less than seven years old and are at Mimosa. These were very severely affected by the drought (see page 85 above), consequently the intended numbers of plants per plot according to spacing no longer holds true. Even if attempts to supply the vacancies with the 1958/59 rains are successful the disparity in ages between the supplies and their more fortunate neighbours will create difficulties for at least some years to come. The future of these experiments is therefore insecure and time alone will indicate their usefulness. As soon as plants are available a new replication of the Complex Experiment will be planted.

Yields for the past season will be presented below as an indication of the effects of the drought but it must be borne in mind that the experiments are in most cases carrying plant populations some 20 to 30 per cent. below their intended quota.

(ii) FOUR SPACINGS AND FOUR SULPHATE OF AMMONIA RATES, MIMOSA

This experiment was planted in 1951 and 1952 and the combined yields recorded below are from tea equivalent to five-and-a-half years from planting at the start of recording. For the first time sulphur was not equalized over plots and no sulphur deficiency symptoms showed.

Two-thirds of the total yields were taken from two complete replications in 1956/57, a good crop season and before the drought, and the remainder from one replication during 1957/58 after the drought. They are therefore in total much higher than straightforward 1957/58 yields.

The main effects of nitrogen rates over the past season are recorded in Table XIV.

TABLE XIV
Effect of increasing Nitrogen Rates on the Yields of Tea 5½ Years Old

lb. N. per acre	40	80	160	240	L.S.D.
Yields lb. m.t.p.a.	1,159	1,214	1,305	1,236	P=0.05=108

C.V.% 1957/58, 10.34% ; 1956/57, 7.48%.

For the yields recorded above, N160 has yielded significantly more than N40. The increments due to the upward steps in nitrogen are not, as is usually experienced, linear and this result is therefore peculiar and should be treated with caution.

Spacing effects however caused significant differences as can be seen in Table XV.

TABLE XV
Effect of Spacing on the Yields of Tea 5½ Years Old

Spacing	4' × 4'	4' × 3'	5' × (2½' × 2½')	4' × (2' × 2')
Yields m.t.p.a.	1,091	1,248	1,244	1,331

L.S.D. P=0.05=108
P=0.01=147

At P=0.01, all spacings have significantly outyielded the 4' × 4' square spacing. There are no other significant differences.

There is no significant interaction between nitrogen rates and differing spacings.

(iii) "COMPLEX" EXPERIMENT, MIMOSA

There are three complete replications in this experiment and they were planted in three successive years starting in December, 1952. Each replication has provision for comparing four sets of main treatments each at three levels but at present only spacing and nitrogen rates are in operation.

Yields in lb. made tea per acre according to spacing for the past season and the preceding one for comparison, are recorded in Tables XVI, XVII and XVIII.

TABLE XVI
Yields according to Spacing from Replication I, planted December, 1952

Spacing				4' × 4'	4' × 3'	4' × (2' × 2')	L.S.D.	
Theoretical plants p.a.	..	..	..	2,720	3,630	7,260		
Actual 1957/58	..	..	..	1,930	2,480	4,520	0.05	0.01
Yield 1956/57 m.t.p.a.	..	..	..	1,116	1,288	1,646	59	79
Yield 1957/58 m.t.p.a.	..	..	..	240	269	279	26	none

C.V.% 1957/58, 17.70% ; 1956/57, 8.01%.

Both of the closer spacings have significantly outyielded the 4' × 4' square planted tea in 1957/58. There is no significant difference between the two closer spacings. This experiment was one of the hardest hit by drought of all the fields at Mimosa and it was not until nearly the end of March, 1958, that any appreciable amounts of leaf were harvested. Recovery from defoliation was very slow. The contrast with the previous season's yields tells a dismal story.

TABLE XVII
Yields according to Spacing from Replication II, planted December, 1953

Spacing				4' × 4'	4' × 3'	4' × (2' × 2')	L.S.D.	
Theoretical plants p.a.	..	..	..	2,720	3,630	7,260		
Actual 1957/58	..	..	..	2,210	2,870	5,110	0.05	0.01
Yield 1956/57 m.t.p.a.	..	..	..	668	764	949	33	44
Yield 1957/58 m.t.p.a.	..	..	..	300	320	336	27	none

C.V.% 1957/58, 15.46% ; 1956/57, 7.79%.

At P=0.05 the closest spacing has significantly outyielded the widest, there being no other significant differences.

TABLE XVIII
Yields according to Spacing from Replication III, planted November, 1954

Spacing				4' × 4'	4' × 3'	4' × (2' × 2')	L.S.D.	
Theoretical plants p.a.	..	..	..	2,720	3,630	7,260		
Actual 1957/58	..	..	..	2,300	2,880	4,430	0.05	0.01
Yield 1956/57 m.t.p.a.	..	..	..	228	266	365	20	27
Yield 1957/58 m.t.p.a.	..	..	..	188	193	190	none	none

C.V.% 1957/58, 14.60% ; 1956/57, 12.88%

There were no significant differences in yield due to spacing during 1957/58.

From the above tables it will be seen that these experiments have suffered in every respect from the drought. In all cases the standard errors have increased. The actual numbers of plants still alive are seriously below the intended numbers. Yields in every replication are lower than for the preceding season and this is a combination of lower plant numbers and delayed cropping whilst awaiting recovery from drought.

In no replication were significant differences in yield brought about by nitrogen applications.

In summary, the past season undoubtedly caused a major tragedy as far as the Complex Experiments are concerned and it could be no earlier than 1967 before it would be possible to bring replacements to the stage that the originals had reached at June, 1957.

Permanent Shading of Mature Tea

(i) SHADE TREES AND N.P.K. MIMOSA

The main treatments are three shade tree species and no shaded tea and superimposed on these, are sets of sub-treatments designed to assess the effects of the three major fertilizer nutrients in relationship with shade. The fertilizers were applied for the second consecutive year in November, 1957.

Shade trees by themselves have caused significant differences in yield as can be seen in Table XIX below. The tea was five-and-a-half years old from planting at July, 1957, the start of the season, and the shade trees are one year younger. During the season *Glyricidia* made very heavy aerial growth and had to be severely lopped on two occasions. The *Albizzia* trees, planted at 40 feet square, developed rapidly throughout the season giving what appeared to be, judging from the etiolation of the tea bushes below, a too dense shade at too low a level. After consideration it was decided in the end not to lop off the lower branches to let in more air and light, but it is probable that this was a wrong decision.

TABLE XIX
Effect of Shade Trees on Yield in lb. m.t.p.a.

Shade			<i>Glyricidia</i>	<i>Albizzia</i>	None	<i>Grevillea</i>	L.S.D. = 0.05
1956/57	..	..	821	898	947	968	48
1957/58	..	..	472	578	756	736	157

C.V.% 1957/58, 6.80% ; 1956/57, 1.44%.

During the past season No Shade and *Grevillea* have significantly outyielded the *Albizzia* and *Glyricidia* treatments. There are no other significant differences.

No fertilizers caused significant responses when considered by themselves or in interplay with the shade.

In May, 1958, gypsum soil moisture blocks were sunk at depths of 1, 5 and 10 feet in each of the 64 plots of the experiment.

(ii) OBSERVATION PLOTS, SWAZI

The scope of this observational area was increased this season. Three years ago following a heavy down prune of the 25-year-old tea, *Grevillea* trees were satisfactorily established in another section of the field. Recording of the full field started this season and there are now two unshaded areas; another shaded with mature *Albizzia gummifera* trees some forty feet high with canopies offering a dappled shade and held well above the plucking table and a fourth area slightly shaded with three-year-old

Grevillea saplings. Each of the four areas is split into two; one half receiving no sulphate of ammonia and the second the equivalent of 80 lb. N. per acre as sulphate of ammonia. Because the *Grevillea* shaded area and its unshaded counterpart had received full fertilizer dressings until the start of this season a direct comparison cannot yet be made with the *Albizzia* plots and their unshaded counterparts which have received sulphate of ammonia according to plan for the previous seven years.

Plots were pruned in early April, after a late beginning to the cropping season and yields are therefore low.

TABLE XX
Yields in lb. m.t.p.a. under *Albizzia* gummifera Shade

			<i>Albizzia</i>		mean for nitrogen
			without	with	
without nitrogen	..	..	320	469	395
with nitrogen	..	..	592	563	578
mean for shade	..	..	456	516	

For the first time in the three years following the heavy down prune shade has had a beneficial effect on yield. It is possibly of importance in considering the beneficial effect of the shade that during the past season the tea was in its third and last year from prune and carried a full top hamper throughout the drought. As recorded in previous seasons *Albizzia* shade has again reduced the efficiency of nitrogen responses—from the unshaded plots the return per pound of added nitrogen was 3.40 lb. of tea in contrast with 1.18 lb. obtained under shade. Shaded tea with no nitrogen yielded more than its unshaded counterpart.

TABLE XXI
Yields in lb. m.t.p.a. under Young *Grevillea* Shade

			<i>Grevillea</i>		mean for nitrogen
			without	with	
without nitrogen	..	..	427	534	481
with nitrogen	..	..	666	675	671
mean for shade	..	..	546	605	

In this first year of records it appears that the young *Grevillea* plants are having a beneficial effect (? primarily that of windbreak) and that they are also causing a decreased response to nitrogen.

(iii) GENERAL

Observations on the *Mimosa* experiment and field experience on estates during the past season, particularly in Cholo with young tea fields shaded by young *Albizzia* trees, has suggested that over-shading of young tea is detrimental. The optimum shade density is not known. Young *Albizzia* trees are difficult because of their tendency to grow comparatively slowly for the first four years and thereafter to burst into vigorous growth which causes a heavy low shade near the plucking table. Good results were seen where this low growth had been judiciously thinned. As the trees grow older the shade tree canopy is carried well above the plucking table.

In the case of mature tea shaded with high *Albizzia* the problem does not arise and consequently there appears to be no case for excessive thinning or entire removal of young shade trees.

Vegetative Propagation

(i) TIME OF TAKING CUTTINGS IN RELATIONSHIP TO THE BANJHI CYCLE

It was noticed some years ago on one estate that cuttings taken at comparatively regular time intervals from single mother bushes did not survive and produce shoots as might be expected according to the time sequence. Thus some plots were apparently more successful than plots planted at later dates and at the time there appeared to be no logical reason for the phenomenon. Later a hypothesis was developed that an explanation might be found in the effects of the banjhi cycle on time of taking cuttings and during 1957 it was possible to do preliminary tests.

In *Nyasaland Farmer and Forester* Vol. 1; 1953, page 25, observations were recorded on banjhi counts for the 1951/52 season. These were made by tagging 200 terminal buds on unplucked seed bearers and recording once a week the percentage which were growing or dormant (banjhi). In 1952/53 no counts were taken but thereafter the observations were continued without break until 1956/57. The results are recorded graphically in Figure 4 where it will be seen that comparatively regular patterns of growth and dormancy are produced each season. At the end of the 1955/56 season a large number of the original terminal buds had ceased to grow and 200 new tags were therefore placed before the start of the 1956/57 season which accounts for the apparently larger than usual percentage of growing buds throughout that season—particularly at the beginning. The important point to note in these graphs is not absolute maximum and minimum values between seasons, as these are affected to some extent by the proportion of buds which ultimately cease to grow at all, but rather to note the relative times of the peaks of flush and dormancy valleys. There has been a comparatively uniform pattern produced between seasons although the times of maxima and minima values can shift either way by as much as a month.

A series of similar observations carried out on seed-bearers on a Cholo estate for one season showed the same rhythm although the times were out of step by about four weeks in comparison with Swazi data for that year.

Counts on clonal material in the Swazi nursery showed similar patterns. Two clones were chosen for the experiment (SW3 and SW4) for no reason other than each had been multiplied sufficiently to give adequate planting material for these preliminary tests.

Starting at the beginning of December, 1956, single node cuttings were taken from each clone and planted every second day until June, 1957, and at each date a record was made of the percentage banjhi or growing buds on parts of the parent clones set aside for these counts. At the end of four months from the date of planting, percentage survival counts were made on the cuttings and these were then back-dated to the time of taking, for comparison with the banjhi counts at that time. The smoothed data is recorded in Figure 5 from which it is clear that there is a relationship between flush (or banjhi) state and the survival of cuttings. In general, best results are obtained when the parent material is in a dormant condition and worst results at the height of a flush. More specifically, the very best results for both clones were obtained shortly after the break of a banjhi period when about 10 per cent. of terminal buds were growing. Rainfall after planting appeared to have no obvious effect on the cyclic nature of the curves and this preliminary trial appears to offer support to the original hypothesis that the banjhi cycle has an important effect on survival of cuttings—although at present the reason why is not known. The experiment is being continued in more detail.

No precise trial has been made with root cuttings but from approximate data available it appears more than probable that a similar interplay is occurring between survival of root cuttings and the banjhi cycle.

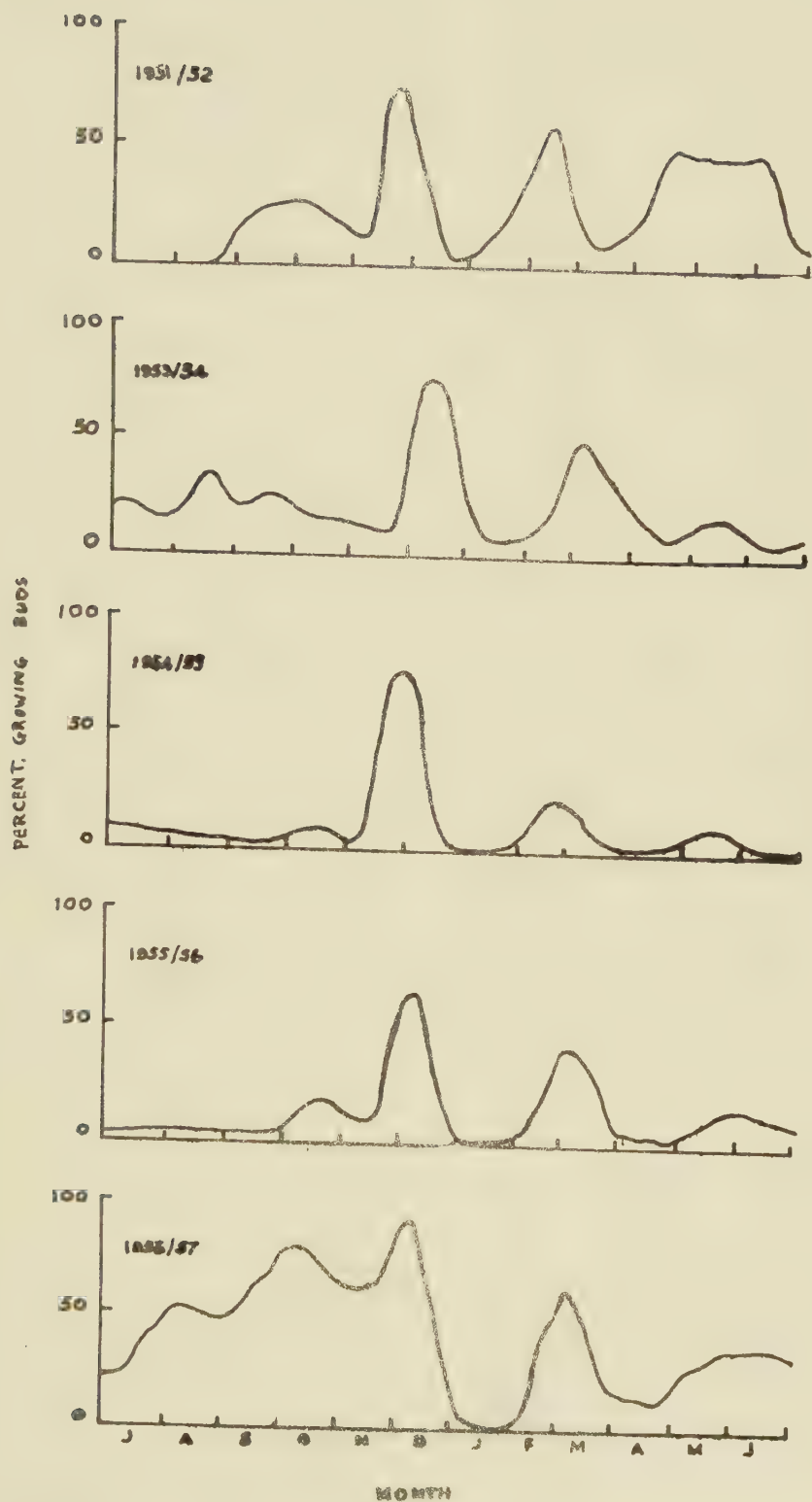


FIGURE 4. Seedbeener bonjhi cycles, Swazi

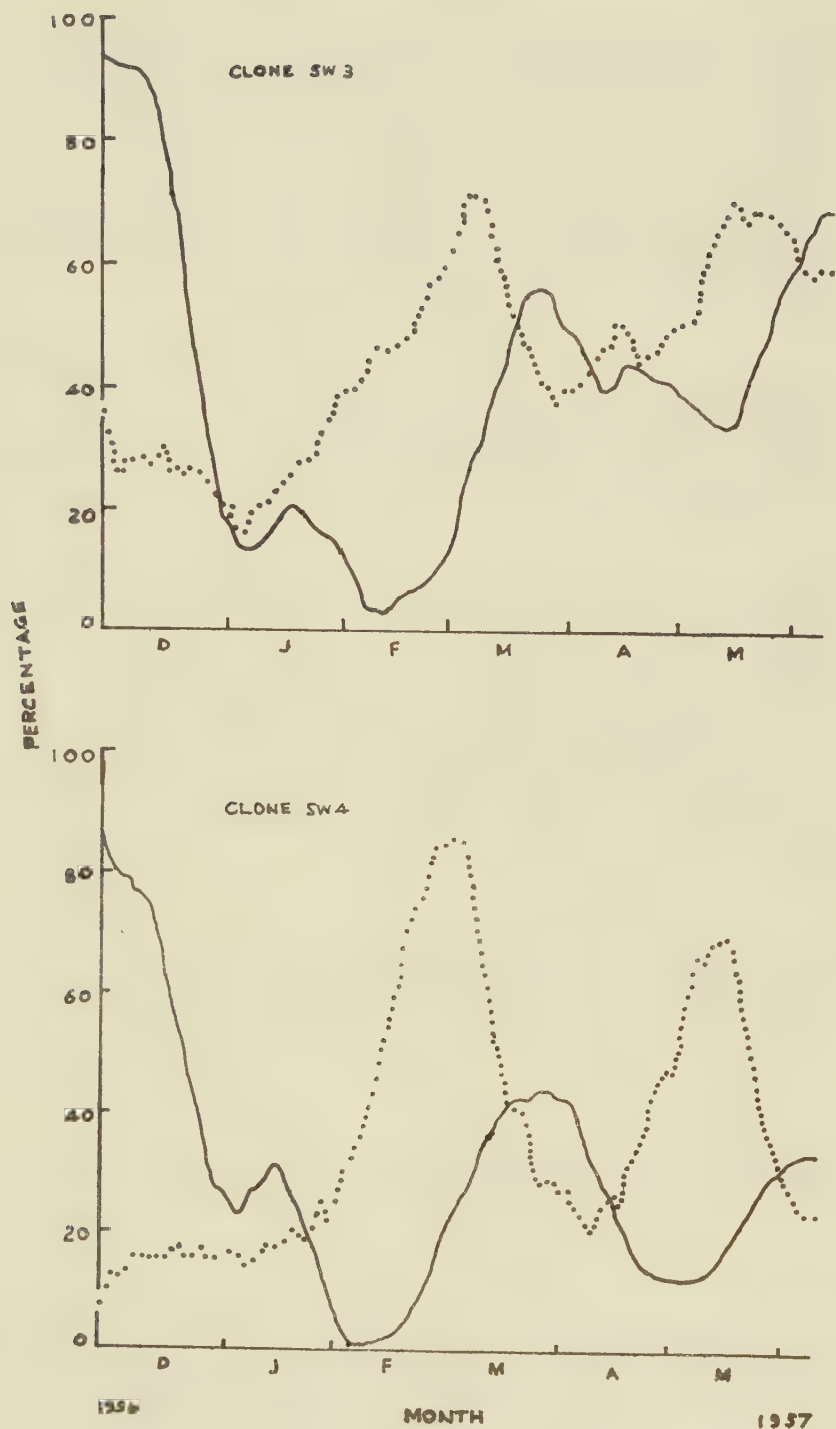


FIGURE 5. % growing apical buds —, and survival of related cuttings

A matter, not connected with survival, is nevertheless of interest from the selection point of view and can be noted in Figures 4 and 5. It will be seen that the banjhi valleys for the two clones occurred approximately one month later than the average for 1956/57 taken from the mixture of seed bearers. Detailed single bush observation on seed bearers, on clones and on field selections show that individual bushes can flush or go dormant, out of step with the average curve. This is perhaps an important indication for a selection characteristic in that it might be possible to choose a mixture of clones which will between themselves smooth out to some extent at least, the extremes experienced from seedling grown tea and consequently make field and factory management easier. This point will require testing on a field scale in due course.

(iii) FERMENTERS AND NON-FERMENTERS

With the good help of estates, selections have been made over the past two seasons of poor or non-fermenter bushes and good or excellent fermenters from widely spaced representative samples of jats and soil types. These will ultimately be required for breeding purposes and biochemical investigations. In April/May, 1958, some 10,000 cuttings were taken from these selections and planted at Mimosa to form 35 clones.

(iv) FORMAL FACTORIAL EXPERIMENTS

In May, 1958, two factorial experiments were started using single node cuttings and comparing the following treatments:

- a0 Before planting, cuttings dipped in water only (there is no esoteric significance in this treatment—it is a control against the two treatments using plastic transplanting compound mixed in the same water).
- a1 Cuttings dipped before planting in plastic transplanting compound at the volume concentration of 1 part compound to 8 parts water.
- a2 As for a1 but strength of solution 1 part compound to 4 parts water.
- b0 Clone SW1
- b1 Clone SW6
- b2 Clone B10

The nursery beds were surrounded with open-work brick walls of the Assam pattern and the individual plots were shaded according to the experimental plan with frames covered with:

- c0 1 layer grey sheeting
- c1 2 layers grey sheeting
- c2 3 layers grey sheeting.

Light measurements with a Western exposure meter yield the following reduction in full outside light values under the shades:

- c0 reduced by 1/4
- c1 reduced by 1/16
- c2 reduced by 1/64.

Two experiments were planted, one using green wood cuttings (discarding the top two-and-a-bud) and the second using the red wood below. In view of the importance of the flush state described above, banjhi counts were taken on all shoots and the three clones were found at approximately the same stage when planted.

Two series of counts are being taken; survival percentage and the number of new shoots produced. Unanalysed results at the end of the 15th week after planting are given in Tables XXII and XXIII.

TABLE XXII
Percentage Survival and Numbers of Shoots after 15 weeks
Green Wood Cuttings

		<i>Transplanting compound</i>			<i>Clone</i>			<i>Full light value times</i>		
		0	1:8	1:4	SW1	SW6	B10	1/4	1/16	1/64
Percentage survival	..	93	89	90	91	89	92	87	90	95
Number of shoots	..	39	67	79	18	8	159	64	76	45

TABLE XXIII
Percentage Survival and Numbers of Shoots after 15 weeks
Red Wood Cuttings

		<i>Transplanting compound</i>			<i>Clone</i>			<i>Full light value times</i>		
		0	1:8	1:4	SW1	SW6	B10	1/4	1/16	1/64
Percentage survival	..	76	78	75	77	75	77	71	78	80
Number of shoots	..	96	66	82	32	26	186	114	78	52

At the time of recording, red wood cuttings have yielded less survivors than the green wood cuttings but they are yielding more shoots. In neither case does transplanting compound appear to have had a pronounced effect on survival but with the green wood cuttings it appears to have had a beneficial effect on the number of shoots produced. Clonal differences are appearing both in survival and shooting and B10 appears to be an early and vigorous shooter. The effect of shade is two fold; increasing shade so far has slightly increased the number of survivors but decreased the numbers of shoots produced.

Final formally analysed results will not be available for some months to come. A trial during the past year has a direct bearing on the interpretation of the above tables. Single internode cuttings were planted and four months later 29.2 per cent. had survived and of these 94.8 per cent. had produced good preliminary root growth. It appears therefore that survival after four months is closely correlated with root development under Nyasaland conditions.

(v) MISCELLANEOUS

Some mention must be made of results over the season which are not obviously open to criticism and confusion because of the banjhi cycle influence on survival.

In a media observational trial, a mixture of soil, sand and peat in equal proportions by volume gave the best result and nursery soil alone was next best. Pure sand did not support survival at the end of seven months.

Following the policy of trying all possibilities out under our adverse conditions it was found that cuttings with leaves pointed to the west gave 7 per cent. more survival than those pointing to the east or south and 17 per cent. more than those pointing to the north.

Some four months old cuttings were transplanted to the field by Herschall transplanter at the beginning of the rains—survival was very poor. A Cholo estate has had good results on a small field scale in transplanting cuttings as 18 months or 30

month-old stumps and it appears that this must eventually become the accepted method. Cuttings have been transplanted to nursery beds to be eventually used in transplanting trials.

Air layerings using a full girdle wound surrounded by vermiculite or sphagnum moss is being pursued. There are no results to comment on as yet in this trial.

Clonal seed plots of known maternal parentage were planted at Swazi.

Plant Breeding

SELECTION

The unprecedented drought during the first half of the season provided a unique opportunity for the selection of drought resistant types, and resulted in an initial selection of some 400 bushes out of 20 acres. These selections were subsequently tested for yield, fermentation, pubescence, etc., and a final selection of 40 bushes was made. These mother bushes will be propagated vegetatively later in 1958 for further field testing of clones in comparison with seedling progenies from all available seed sources in Nyasaland and other parts of Africa. Some of the named jats available include Betjan, Dahoota, Dangri, Rajghur, and Kalline.

BREEDING

Approximately 1,500 seedling selections were planted out in three isolated areas on the station.

The " Jat Museum " was started with an initial planting of ten jats from local seed gardens as well as other well-known jats from East Africa.

Six seedling " types " were selected and propagated vegetatively as a start to the study of juvenile characters in relation to the mature bush. Criteria for selection in these cases were based on leaf size, shape, position on stem, colour, and thickness of cuticle.

SEED CERTIFICATION

A further seven seed gardens were tested for purity but none reached the minimum standard of less than 1 per cent. non-Indian types required for certification.

Meteorological Record 1957/58 at Mimosa Tea Research Station, Mlanje

<i>Month</i>	<i>Rain ins.</i>	<i>Rainy days</i>	<i>Running total</i>	<i>9 year mean</i>	<i>Mean monthly max. °F</i>	<i>12 year mean</i>	<i>Mean monthly min. °F</i>	<i>12 year mean</i>	<i>Hours sun</i>	<i>4 year mean</i>
July, 1957 ..	0.06	2	0.06	1.30	78.4	74.8	49.9	51.1	271	201
August ..	0.08	2	0.14	1.54	79.8	78.7	55.1	51.5	214	223
September ..	0.35	3	0.49	0.55	88.0	84.2	60.6	56.8	225	211
October ..	0.62	3	1.11	2.62	93.3	90.3	64.0	61.6	295	283
November ..	1.10	4	2.21	7.46	96.5	87.9	68.4	64.9	288	204
December ..	14.34	22	16.55	11.11	82.8	86.2	66.3	65.8	147	152
January, 1958 ..	8.40	22	24.95	12.11	84.9	84.5	68.6	65.9	153	161
February ..	11.41	21	36.36	10.98	82.3	84.3	67.7	65.7	121	166
March ..	5.63	14	41.99	11.73	82.8	82.3	64.4	64.8	229	168
April ..	3.34	7	45.33	6.43	83.5	81.7	63.0	61.9	243	200
May ..	2.08	6	47.41	3.06	79.5	77.5	57.0	56.2	251	208
June ..	3.45	11	50.86	2.17	72.1	73.7	55.7	52.4	147	146
TOTAL ..	50.86	117	50.86	71.06	—	—	—	—	2,584	2,323

Extract from Report of the Agricultural Chemist, Bvumbwe

SUB-STATION IN CHOLO—SOIL SURVEY

Following the proposal to establish a Tea Research Sub-Station in the Cholo area, a preliminary survey of three suggested sites was made.

The third site, at Nchima Estate, provided the most satisfactory area of soils, and was thus surveyed and mapped in greater detail. There are two main soil series, both typical of, and widely found in the Cholo District.

(i) A sandy loam top soil overlies a sandy clay loam of increasing clay content with depth. This is derived from basic rock. In the north of the area, dolerite rock is found in the profile, but in the south, rock appears to be less prevalent.

(ii) Soils derived from more acidic rock present more sandy soils on top, and the profile contains quartz horizons, or gravelly quartz at various levels. These soils occur in the extreme north, and in the central area.

The survey of the Nchima site thus indicated that though the southern part of the proposed area does not offer such a high proportion of the best tea soils, as did the northern portion originally examined, the whole area of approximately 160 acres, will provide 60 acres of deep loams (allowing 10 per cent. for steepest slopes) for immediate development with further areas of rather more gravelly soils that will in themselves be useful for examining extreme Cholo conditions.

SOILS AND NUTRIENT STUDIES

Northern Province Tea

To assist the new tea estate established at Chombe near Nkata Bay, samples of leaf from the plots at Mzuzu, where the tea is about eight years old, were examined. Their composition was as follows:

			Ash	N	P	K	Ca	Mg.
Two + bud	..	..	7.0	5.1	.36	1.5	0.4	0.2 per cent
4th leaf	..	..	6.9	3.1	.19	1.0	0.6	0.3 „ „

The soil on this plot contained 0.2 0.3 m.g.e./100 of potassium, and is generally similar to the better soils of the Chombe estate. This information appears to confirm observations made in the Southern Province, as detailed in last year's report—that even on soils of lower potash status, sufficient of this nutrient is mobilized to maintain an adequate supply to the bush.

Samples of tea leaf showing symptoms of “ yellows ” were examined for sulphur content. Those with “ yellows ” contained only one-tenth of the sulphur found in the normal green leaf, the content of the latter being 300 p.p.m.

In connection with the prevention of “ yellows ” by ensuring that the requisite amounts of sulphur are applied by estates, a sample of newly available fertilizer—ammonium sulphate nitrate—was found to contain 15.1 per cent. sulphur conforming to an equimolecular mixture of ammonium sulphate and ammonium nitrate. Thus for every unit of N used, the amount of sulphur applied will only be half of that contained if the equivalent N were applied as ammonium sulphate.

Similarly, in anticipation of the fact that urea may become the main source of nitrogenous fertilizers in the next few years—the best way of utilizing this, and the required periodicity of sulphur applications, is catered for by the planning of a “ forms of fertilizer ” field experiment.

Replanting of Tea

An area of a Cholo estate was examined to assess its suitability for replacement of 50 year old tea. The soils appeared satisfactory, being generally red deep loams, although one corner of more gravelly soils would probably better be avoided. It was interesting to note that the soil potash was lower here than on an area of the estate carrying younger tea, which had been previously examined.

TEA FERMENTATION

The investigations outlined in last year's report have not been extended greatly because of new proposals regarding this investigation, for during the visit of Sir Frank Engledow in September, 1957, it was suggested that the Department of Biochemistry of Cambridge University might be interested in pursuing the problem. In April, 1958, Professor Young and Dr. Hill of that Department visited Nyasaland, to assess the problem, and prepared a brief report for the Nyasaland Tea Association who are now sponsoring a three year project. Dr. Bendall was subsequently appointed to the position of Biochemist and arrived in October for a preliminary study of the various field and laboratory factors involved.

Before these arrangements were finalized, some additional work had been done. Because of the possibility of slow action of the copper sulphate applied to the soil last year, further leaf samples were taken from one estate in Mlanje for copper content. A further manufacturing trial was also made—but again no marked difference was noticeable, and the copper content of the leaf from the various plots was very similar.

To obtain some comparison between Nyasaland made teas, and those of other areas, experiments using extracts of water and sodium bicarbonate were made. The red colour of the infusion was assessed in the colorimeter using the 303 (blue) filter. Preliminary figures suggested that a low bicarbonate/water ratio was associated with a better quality tea, but examination of a wider range of teas did not confirm this. Typical figures for 0.1 per cent. solutions are shown below. Infusions at 1.0 per cent. strength were also made but with no more informative results.

Details	Quality assessment	Colorimeter bicarb.	Readings water	Bicarb/ water
Assam Orthodox	Good	85	35	2.4
„ C.T.C.	„	90	26	3.4
Darjeeling-high grown ..	„	87	20	4.2
Ceylon „ „	„	71	28	2.5
„ „ Low „	„	81	22	3.6
Doars	Medium	83	21	4.0
Travancore	„	88	25	3.5
Sylet	Poor	87	20	4.3
„ „	„	93	24	3.9
Nyasaland I	—	93	26	3.6
„ II	—	80	20	4.0
„ III	—	91	23	3.9

From studies made of the absorption curves of some of these solutions both in the visible and ultra-violet range, it appears that the comparison of the action of these extractants might give useful information, but in view of the appointment of a biochemist for this work this aspect has not been pursued.

TUNG

The tung industry has suffered from a severe price recession and no further expansion can be contemplated. Much of the experimental work at Bvumbwe has therefore had to be curtailed on the tung crop and directed instead to alternative sources of income, the most important being coffee, and pastures for livestock.

1. Production of Improved Planting Material

It is desirable that any new material should there be a renewed demand for oil.

1. 1. BUDDINGS VERSUS SEEDLINGS

The experiment in Field 4 can be regarded as "classic" having run for 18 years and being the oldest planting of recorded tung in the country.

TABLE I
Buddings versus Seedlings, 1958
(Yield in lb. air dry seed per tree)

Treatment	Clones				Mean	Mean Yield per acre	L.S.D.	
	M8	M13	M14	F9			P=0.05	P=0.01
Montana stock ..	21.3	30.9	27.4	23.6	25.7	1,439	8.5	11.8
Fordii Stock ..	19.8	16.1	30.6	23.7	22.6	1,265	(476)	(586)
Selected Seedlings ..	23.2	10.5	10.9	12.4	14.3	801	—	—
Unselected Seedlings ..	—	—	—	—	14.9	834	—	—
Clones—Mean yields per acre (short tons) ..	1,081	1,075	1,282	1,114	—	—	—	—

L.S.D. Clones

P=0.05 .. 5.3 (299) Coefficient of variation: 35 per cent.

P=0.01 .. 7.1 (399)

This year's results are in keeping with those obtained in previous years. Buddings of selected clones on *montana* are significantly better than seedlings. M13 is the only clone in which buddings on *montana* are significantly better than buddings on *fordii*.

Yields in this field have been strongly biennial and on the cycle a higher yield could have been expected this year, but biennial bearing shows some correlation with rainfall. Conditions were dry during the period of flower bud formation in 1957 and it is therefore not surprising that yields did not greatly exceed last year's.

The second year's crop from the trial of eleven selected *fordii* seedlings and buddings from United States, Swaziland and local sources repeat the pattern of last year's results.

TABLE II
Fordii Seedlings and Buddings, Second Cropping year

Clone					Mean Yield per tree	L.S.D. P=0.01
Montana clone 10 on <i>montana</i> rootstock ..	..	..	..	..	9.98	0.29
Local <i>fordii</i> seedlings NZ. 101 ..	..	..	..	..	0.73	—
" " " NZ. 5 ..	..	..	..	..	0.56	—
<i>Fordii</i> seedlings ex-Swaziland ..	..	..	..	..	0.36	—
U.S.A. <i>fordii</i> seedling Gahl ..	..	..	..	..	0.30	—
" " " Lampton ..	..	..	..	..	0.24	—

None of the *fordii* selections either in the experiment or in observation plots nearby have produced a crop comparable to the *montana* clone 10. This should prove finally to those growers who have considered it, that planting *fordii* tung in preference to *montana* selections is not an economic proposition. Recording of this experiment has now been discontinued.

1. 2. CLONAL TRIALS

A fifteen year old clonal/manurial trial which is to be abandoned this year contains six clones which were widely-planted.

The first to come into bearing were the dwarf B-type N4, the vigorous B-type 04 and the precocious A-type C2A, but in later years they were all outyielded by the A-types M8 and M13. They were all planted at a spacing of 28' × 28' and the table below shows the yield per acre that might be expected if they were planted at the optimum spacing for the growth they have made in that particular field.

TABLE III
Yields of 15 year old clones

Clone and type	Yield 1954-58	Mean Yield Per tree	Optimum Spacing	Estimated Yield per acre
M8, A-type	122.0	24.4	28' × 28'	1,366
M13, A-type	122.9	24.6	28' × 28'	1,378
N10, A-type	97.0	19.4	28' × 28'	1,086
C2A, Precocious A-type	94.9	19.0	25' × 25'	1,311
04, Vigorous B-type	93.5	18.7	25' × 25'	1,290
N4, B-type	69.7	13.9	20' × 20'	1,515

It is now possible to obtain a true appreciation of the 32 newer clones at Bvumbwe which were planted in 1947. The first crop was taken in 1952. Those which have given an overall better yield than either M13 or 10 are listed below.

TABLE IV
New Clones at Bvumbwe
(lb. dry nuts)

Clone	Total Yield per tree 1952-1958	Mean Yearly Yield	Mean Yield per acre at 27' × 27'	Remarks
G87	167.4	23.9	1,338	Vig B-type
G96	163.1	23.3	1,305	A-type
G88	161.8	23.1	1,294	A-type
E565	160.8	23.0	1,288	Vig B-type
G112	159.7	22.8	1,277	Vig B-type
G69	158.6	22.7	1,271	Vig B-type
G43	151.9	21.7	1,215	A-type
E658	149.7	21.4	1,198	A-type
G184	147.6	21.1	1,182	Vig B-type
G57	146.5	20.9	1,170	Vig B-type
A682	145.3	20.7	1,159	A-type
G184	140.6	20.1	1,126	Vig B-type
G72	138.9	19.9	1,114	A-type
10	128.5	18.1	1,014	Widely planted Vig B-type
M13	133.5	19.1	1,070	Widely planted A-type

G112 and G96 might be noted for consistently high yields over the years. G87, G88, E565 and G69 yielded heavily in 1957 and two of them, G87 and G69, produced above average yields again in 1958. Male trees topworked with E460 have yielded for the last two years and the mean for these two years was 28.7 lb. per tree (1,697 lb. per acre) which is a particularly good performance.

Due to the prolonged dry conditions last season the Nabomba clonal trial yields were so low that no conclusion can be drawn from them except that in 1957 and 1958 clone F660 (E464) has yielded outstandingly higher than all other clones.

In the collection of crossed and selfed *montana* B-type seedlings, a proportion of the trees are cropping well enough to form a nucleus of mother trees for future propagation. Of these, E464 × 14, 9 selfed and 14 selfed have produced the highest proportion of trees yielding over 10 lb. dry nuts; but of those trees yielding over 10 lb. 14 × 10 and 10 selfed hold the highest averages, the best being 18.5 lb. which at a close spacing of 15' × 15' represent a yield of 3,570 lb. per acre. Before any of these varieties can be firmly recommended it would be necessary to test selected mother trees as clonal buddings.

A selection of F₁ seedlings from *montana* × *fordii* hybrids has been planted out. They are generally less vigorous than *montana* seedlings.

It is not intended to continue further with work on tung breeding unless a revival of the industry could be envisaged.

2. Fertilizer Trials

The N.P.K. experiment at Bvumbwe, which has run for 15 years, is to be abandoned this year and the field to be put on a "care and maintenance" basis. Throughout the experiment the trees have responded only to applications of nitrogen (3 lb. sulphate of ammonia per tree or 170 lb. per acre).

TABLE V
N.P.K. Trial at Bvumbwe, 1958
(Yield dry nuts lb. per acre)

Experi- mental mean	Increase due to Nitrogen	L.S.D. P=0.01
934	237	103

Coefficient of Variation=32.7%

1 lb. of sulphate of ammonia per tree applied since 1956 and 3 lb. since 1957 to hitherto unfertilized plots resulted in no increase in crop. This should be compared with last year's results where tung was growing on a poorer soil (page 106, paras. 2 and 3).

Similar results were obtained from Mzuzu on the Vipya (see Table VI below).

TABLE VI
N.P.K. Trial at Mzuzu

	N ₀ *	N ₁	N ₂	N ₃	L.S.D. P=0.01
Yield per tree	9.1	14.2	14.2	18.6	6.4
Yield per acre (65 trees per acre) ..	591	923	923	1,209	416

Coefficient of Variation=30.8 per cent.

*N₀, N₁, N₂, N₃=0, 1, 2, 3 lb. sulphate of ammonia per tree respectively.

Assuming a price of 2d per lb. for dry nuts, an increase of 332 lb., worth 55s-4d, was obtained by the application of 2 lb. (130 lb./acre) per tree of sulphate of ammonia at a cost of 29s-1d (£22-7s per short ton). Similarly, the application of a higher dressing gives a proportionately higher yield. On the soils of Mzuzu high rates of fertilizer appear to be more justified than at Bvumbwe.

2. 2. N.P.K. WITH COPPER AND ZINC

Responses were obtained to nitrogen only at Bvumbwe and Gala.

TABLE VII
N.P.K. Cu Zn Trials, yield per acre
(lb. dry nuts).

				Experimental Mean	Increase due to Nitrogen*	L.S.D. P=0.01
Bvumbwe	..	..	..	1,273	276	194
Gala	..	..	..	800	384	183

*i.e. 3 lb. sulphate of ammonia per tree.

These two experiments repeat the results published in last year's report. The coefficient of variation for the experiment at Gala is well over the usual figure for tung experiments of 25-35 per cent. and no importance can be attached to a significant increase at the 1 per cent. level to zinc in the presence of nitrogen and copper. This experiment is to be abandoned.

Both the NPKCuZn and the NPK experiments illustrate the greatly increased response that can be obtained from the use of sulphate of ammonia on the poorer soils of Mzuzu and Gala, as compared with Bvumbwe.

2. 3. NITROGEN

The nitrogen fertilizer trial has been modified so as to test the effect on the trees under the different fertilizer treatments of underplanting with *Paspalum notatum* grass. The object of the planting is to provide a supplementary income to the grower in the form of grazing for livestock.

The grass has not yet had time to show any effect and the figures below reflect only the fertilizer effects.

TABLE VIII
Nitrogen Fertilizer Trial on Montana Trees
(Yield per acre of air dry nuts).

Pounds per tree, sulphate of ammonia				L.S.D. P=0.05
0	2	4	6	
1,158	1,879	2,301	2,074	657

Coefficient of Variation=35.2 per cent.

6 lb. of sulphate of ammonia has not produced a higher yield than 4 lb. per tree, and has seldom done so in previous years.

The experiments on younger trees again show that little is to be gained by increasing the application rate of sulphate of ammonia to 6 lb. per tree. Sulphate of ammonia is superior to tung cake when applied at equivalent rates of nitrogen (4 lb. sulphate of ammonia approximately equals 20 lb. tung cake).

TABLE IX
Nitrogen Fertilizer Trial on Young Trees

Treatment									
	Control 0	Tung cake lb/tree		Sulphate of ammonia lb/tree					L.S.D.
		20	30	2	4	4*	6	6*	P=0.05
Gala (7 years old)									
Yield per tree ..	9.4	9.1	12.7	11.4	14.2	15.8	12.8	12.1	3.6
Yield per acre ..	526	510	711	638	795	885	717	678	202
Nchima (5 years old)									
Yield per tree ..	4.6	5.0	6.3	6.9	7.9	9.7	6.2	6.4	2.2
Yield per acre ..	258	280	353	386	442	543	347	358	123

Coefficient of Variation=25.3 per cent. (Gala) and 32.0 per cent. (Nchima).

*Applications made as follows:

Gala—split applications—October and December.

Nchima—4 lb. applied in July.

6 lb. applied as split applications in July and October.

All other applications are made in late October to November.

There appears to be no advantage in splitting the applications at Gala or Nchima. Neither does there appear to be any loss in applying the fertilizer in July either as one dressing or as a split dressing.

3. OTHER TUNG EXPERIMENTS

Nursery buddings were made of the A-type Clone A43, mature trees of which suffered from premature fruit fall. These buddings displayed the same symptoms. The scions on which they were worked have not shown similar symptoms but it is considered premature to determine whether a transmissible virus is involved or the condition is physiological. The mother tree from which these buddings derived shows no such symptoms.

A study has been made of girth measurements and recorded yields for trees of varying ages. There is a strong correlation which can be used particularly in the years before young trees come into bearing.

Extract from Report of the Agricultural Chemist, Bvumbwe

1. STATUTORY ANALYSES OF EXPORTED OIL

Seventy-one samples from 1,156 tons (of which 20 tons was *fordii* oil) were examined, a few tons of the 1957 crop remaining unsold due to the poor market conditions. The distribution of exports was 489 tons to Europe, 395 tons (including 20 tons *fordii*) to South Africa, 20 tons to East Africa, 250 tons to U.S.A., 20 tons to Australia, and a trial shipment of 1½ tons to Japan.

The general range of chemical constants was similar to that detailed in last year's report, except that the heat test returned to the rather lower figures of 22½–23 mins. for the Cholo area, and 23¾–24½ mins. for the Zomba plantations. The factory of Vipya Tung Estates (C.D.C.) at Mzuzu in the Northern Province, commenced expression this season. The chemical characteristics of the oil confirmed data previously obtained on Vipya seed expressed at the Cholo factory. It complied satisfactorily with the specification, the polymerization time (heat test) however, was higher than both the Cholo and Zomba oils, being 26 mins.

The acidity of all oils was maintained at a low figure, generally below 1 per cent., and well within the specified limit of 2.5 per cent. A quantity of high acidity oil was

however produced at one factory. This was produced from seed which had remained outside in the field, unhulled.

2. COMPOSITION OF TUNG OIL

The higher gelation time given by the Vipya tung oil raises again the question of the effects of climatic conditions on the proportion of unsaturated glycerides in tung oil. This was discussed fully in the 1955-56 report. Examination of meteorological data indicates, that in the Mzuzu area, after the first rains there is usually a drier period in March, with consequent brighter and less cloudy conditions. This would cause the production of less unsaturated glycerides and appears to afford an explanation, since the higher heat test has been checked on oil for three seasons.

This climatic effect has been further demonstrated under very extreme conditions in 1958. Tests on the first production samples of oil, gave high heat test figures. These were 27-28 mins. for Cholo, 30-32 mins. for the Zomba area, and 27 mins. for the Vipya oil. It appears that the exceptionally hot and dry period with clear skies in March, has led to a further reduction in the content of "unsaturated" glycerides. As the Mzuzu ripening period is later than that in the Southern Province, the effect does not appear to have been so great there. Determination of elaeostearic acid content remains to be made, and a fuller report of this phenomenon will be published.

3. OIL CONTENT OF TUNG SEED

In the 1955-56 report, figures for the oil content of tung seed from various fertilizer treatments were detailed. There were indications in the Vipya area, where the soils are generally poorer in potash than are those of the Southern Province, that potash fertilizers increased the oil content of the seed. Further samples of the 1957 seed from Mzuzu were therefore examined, with the following results:

Percentage Oil Content of Seed (dry kernel)

Clone	..	..	O	N	P	K	NP	NK	PK	NPK
Mixed B-types	..	63.3	..	65.4	..	63.8	..	65.6	..	65.0
04	..	..	65.7	..	66.3	..	67.8	..	67.2	..

The previous data is therefore confirmed, although the degree of increase with fertilizer treatment is not so great. This may be due to the fact that during the past year the control treatments gave a rather higher oil content than previously but the general pattern of variation throughout the treatments is similar, e.g. N seems to increase the oil content of the mixed B clones (10, 14, and 04), more than it does of 4. The generally higher oil content (2 per cent. more) of the 04 seed is also noted as was found in the 1956 crop. However, with the present depressed market position, any variations of this degree would not be economic.

COFFEE

1. Cultivation and Manuring Experiments

Experiments mentioned last year were recorded in three climatically different localities and the results are shown in Table I below.

TABLE I
Comparative Data for Three Shade/Mulch Experiments, 1958

Treatment	Yield Clean Coffee, Cwt. ($\times 112$ lb.) per acre			
	Bvumbwe		Naming'omba	Gala
	1958	1957		
M. No shade: mulched	6.6	7.3	10.0	25.3
S.M. Leguminous shade: mulched	4.1	0.9	6.7	24.7
(1) Non-leguminous shade; not mulched*	2.8	0.7	5.8	25.1
S. Leguminous shade: not mulched*	4.4	0.4	6.8	23.1
L.S.D. $P=0.05$	2.4	6.3	2.7	Not sign.
Coefficient of variation	15.8%	—	21.1%	14.1%
Variety planted	KP.228		Local	Brazil

* Except at Bvumbwe where (1) was mulched with cut Napier from January, 1957, and S. was mulched with tung hulls from December, 1955. Mulch at Bvumbwe consists of cut Napier, at Naming'omba of tung nut shells from the factory and at Gala of tung hulls.

The Bvumbwe experiment shows clear-cut differences between treatments. The significant advantage gained by the "M" plots over all others has been maintained. Yields of the other plots are considerably greater than last year's; they are beginning to recover from an initial setback due, in the early stages, to the temporary shade of *Sesbania* (in S and SM plots) and banana (in (1)) and to lack of mulch (in S and (1)).

The yield of 6.6 cwt. per acre for the "M" plots is lower than it was last year (7.3 cwt.). It may therefore be inferred that some overbearing occurred in 1957 and that a more rigorous system of pruning will have to be practised in order to maintain a good average annual yield. Pruning to the "break", i.e. leaving a bearing head of about 3' 6", has been chosen as the optimum for this experiment.

Failure to prune adequately at Gala led to 100 per cent. biennial bearing and no crop last year has been followed by yields exceeding 20 cwt. per acre for all plots. The yields would appear to be good even if spread over the period of two years but they were achieved by a very close planting of 6' $\times$ 6' (1,210 plants per acre) instead of the normal 9' $\times$ 9' (537 plants per acre). The condition of the trees suggests that without corrective pruning their life would be severely curtailed and an expensive programme of re-planting would be necessary.

The experiment at Naming'omba has been so decimated by attacks of *Fusarium* disease that it will have to be abandoned. Corrections have been made for vacancies caused by the disease and yields would then appear to be very satisfactory. The superiority of the "M" plots is again demonstrated. The relative values of the shaded plots cannot be properly assessed as many of the shade trees were cut down.

At other observation plots, mainly in the Northern Province, mulch has been shown to be necessary for satisfactory growth.

The most important response to fertilizers this year was found at Bvumbwe where nitrogen at $\frac{1}{2}$ lb. sulphate of ammonia per tree, applied to coffee under a shade of *Albizzia* and receiving a mulch of tung hulls, gave the yields shown in Table II below:

TABLE II
Yield in Shaded Plots, Cwt. Clean Coffee per acre

<i>No Nitrogen</i>	$\frac{1}{2}$ lb. S. of A. per tree	L.S.D. P=0.05
2.34 	5.41	1.49

At Naming'omba, neither nitrogen nor phosphate produced a significant increase in yield on their own this year but together these fertilizers gave an increase in yield on all plots, particularly on the mulched plots.

An NPK fertilizer experiment was recorded at Nchenachena. The varieties used were Kent's and Local and they were grown on both the single and multiple stem systems. Many vacancies had been caused by the dieback disease *Fusarium stilboides* and one replicate had to be abandoned. However, the indications are, that 6.65 cwt. of clean coffee per acre can be expected from five-year old trees of the Local selection and an additional $\frac{1}{2}$ cwt. per acre from Kent's. Multiple stem system gave a significantly greater yield than single stem system. Dung was the only fertilizer which gave a significant increase in crop and this only on the multiple stem system. Thus the correct management of coffee, particularly in marginal areas, needs constant vigilance and the closest attention.

The NPK manurial experiment on the Vipya was a failure and had to be replanted this year.

Zinc deficiency symptoms have been widespread on young coffee trees particularly on the Vipya, the soils of which are known to be deficient in that element. Spraying with zinc sulphate has helped to clear the trouble, which is manifested as an intervenal chlorosis and dwarfing of terminal leaves. However, the symptom is not purely one of zinc deficiency and this has been confirmed by leaf analyses (*see* report by Chemist). Foliage has remained green very satisfactorily where the trees were sheltered by tung or protected by an artificial grass shade. At Bvumbwe spraying with zinc resulted in no improvement; there was also a marked variation in susceptibility between varieties.

Among those selections least susceptible to chlorosis are some of the best yielders, i.e. Ke20, SL14, SL6, SL28 and Kent's Hybrid from Kenya and N197, N39, N5 and L1 from Tanganyika. The most susceptible were Mocha, Blue Mountain, Dalle Mixed, Moragopce, H133, KP128, KP162 and KP423. Chlorosis was worst in the month of January. "Bunching" of leaves is usually associated with chlorosis and was more marked in the open than in light shade cast by young *Albizzia* at a spacing of 36' x 36'. The varieties SL28, Kent's Hybrid, N197 and L1 were outstanding in showing least symptoms of both chlorosis and "bunching".

An experiment has been planted at Bvumbwe to test the reaction of five different varieties to four methods of handling and pruning. The growth of "Kenya Selected" is considerably superior with markedly less chlorosis than all others.

In the nurseries it is usual practice to closely plant the seed and germinate it in beds and then to transplant and grow on in beds at a spacing of 9" square. The best stand of seedlings has been obtained from those transplanted at the "violet" or cotyledon leaf stage rather than at the first true leaf stage.

2. Variety Trials

None of the formal variety trials has yet come into bearing but the observation plot of Tanganyika selections at Bvumbwe yielded its second crop.

TABLE III
Observation Plot at Bvumbwe

Selection				Yield of Clean Coffee (cwt. per acre)
N197	..	..	..	13.00
N81 ..	..	..	..	10.32
Brazil	..	..	..	8.15
KP423	..	..	..	6.85
KP162	..	..	..	6.83
N39 ..	..	..	..	5.96
L1 ..	..	..	..	5.83
N5 ..	..	..	..	5.29
H66 ..	..	..	..	3.36

The three varieties, N197, N81 and Brazil again head the list and do not appear to have been adversely affected by the high yields of 1957. The recording of dieback made last year appears to give no indication of the yield that might be expected. H66, a heavy yielding variety last year, was one which showed least dieback after cropping, yet it figures as the lowest yielder this year. N5 and N39 are remarkable as vigorous leafy varieties but do not yield heavily; they may be suitable for hot, dry areas where growing conditions would be unsuitable for the heavy yielders. L1 defoliated severely and would not appear to be a variety worth recommending.

Similar yields were achieved in observation plots at Nchenachena and are shown in Table IV below.

TABLE IV
Observation Plot at Nchenachena

Selection				Yield of Clean Coffee (cwt. per acre)
KP423	..	..	..	12.90
H66 ..	..	..	..	12.75
L1 ..	..	..	..	12.25
N128	..	..	..	11.31
H133	..	..	..	11.24
F840	..	..	..	10.88
N197	..	..	..	10.66
KP656	..	..	..	9.15
160 ..	..	..	..	8.50
N5 ..	..	..	..	7.28
P190	..	..	..	6.92
N39 ..	..	..	..	5.62

The extensive plantings which will soon be in bearing necessitate further investigation into the processing of coffee. Two small pulping factories have been built, one at Nchenachena and the other at Bvumbwe. They are mainly designed for dealing with experimental plots. Samples sent to the liquorer in Kenya show that Nyasaland can produce a bold bean which makes an attractive roast and produces a liquor of good acidity and body and good flavour. There was however too much *Antestia* damage and stricter control measures with malathion or DDT are necessary. In the Bvumbwe experiments the attacks on *Albizia* shade trees of a stem boring beetle, *Apate indistincta*, already recorded as a pest of coffee, have been so serious to question the advisability of planting this tree in coffee. Spraying has been necessary but the pest has still spread to the coffee trees.

The dieback disease mentioned last year, *Fusarium lateritium* var. *longum*, is still the disease of major importance and outbreaks have occurred in several areas. Preliminary investigations suggest that it is a disease favoured by factors, not necessarily nutritional, which are limiting to the proper growth of coffee; firm recommendations as to control cannot yet be made but preliminary trials have been encouraging.

An outbreak of the leaf spot disease *Cercospora coffeicola* at Bvumbwe caused serious defoliation and dieback of some trees, particularly of the variety L1.

Copper sprays have been shown to be effective against leaf-fall. The optimum time appears to be early in January but this requires further confirmation; a study is being made of the growth cycle at Bvumbwe. "Damping off" in nurseries has been reported on one or two occasions and has been successfully controlled with Cheshunt compound.

It is now possible, five years after the first coffee experiments were planted, to infer certain basic requirements for coffee cultivation. Mulch is essential. Shade is beneficial, but the plants chosen to provide it must not compete with the coffee for moisture; *Sesbannia* and banana do more harm than good. Shelter is essential and observations on estates have shown the beneficial effect of dividing a plantation into small blocks protected at the boundary with *Grevillea* and/or bananas. A strict regime of pruning multiple stem coffee must be introduced to prevent overbearing. A spraying programme must be adhered to.

Preparations have now been made for the next step, which is to obtain a detailed picture of the areas of Nyasaland most suited for coffee production. Variety trials are being planted this season in twenty-four different areas.

3. Robusta Coffee

Five fertilizer observation plots have been planted in a high rainfall area of Nkata Bay District and growth has been satisfactory.

Extract from Report of the Plant Pathologist

Coffee culture has increased in the Protectorate quite considerably in the last few years, with a consequent increase in pathological interest in this crop as conditions for coffee growing in Nyasaland are, generally speaking, marginal. The most serious disease, or complex of diseases, are those associated with *Fusarium stilboides* Wr. This fungus is consistently found associated with three conditions of coffee in this country:

(1) Storey's bark disease, in which young leader shoots are killed where infection occurs at the point of emergence of the shoot from the main stem, and causes a dark brown constriction, which may extend up the green shoot for as much as 2 inches.

(2) Scaly bark, characterized by a very flaky bark on the main stem, below which flattened lesions occur, usually at the point of emergence of primaries from the main stem.

(3) Collar rot, a wilt described in the last Annual Report.

In vitro studies of the fungus have not proceeded far enough to enable a report to be made, but one or two facts have emerged. Spore trapping, using a trap described by Stephens in *Nature* (Vol. 181) has revealed that spores are liberated immediately after rain. There were sporadic spore showers in October and November, 1957, which were associated with light rain, but the main spore shower did not come

until the middle of December, with the onset of the main rains. The spore shower decreased after the end of December. Sporadic spore showers occurred however until the end of the rains and the peaks of these showers occurred after heavy rain.

A small observational spraying trial conducted in one of the badly affected areas showed Captan and 8-hydroxyquinolinolate to have some promise in effecting control of Storey's bark disease.

An analysis of a coffee experiment at Nchenachena has shown that in those plots which receive an annual dressing of 1 *debe* of dung there is a significantly higher number of deaths due to collar rot than in plots receiving other treatments. This same treatment also gives a significant increase in yield, thus giving grounds for suspicion that debilitation due to overbearing is one factor of importance to be considered in relation to this disease.

Hemileia vastatrix B and Br., though still occurring in the Misuku Hills, is not reported as having been serious there this year.

Cercospora coffeicola B. and C. has again caused some damage in nurseries. Considerable defoliation of mature coffee in localized areas was caused by this fungus towards the end of the crop year. Associated with this was a berry disease caused by the same fungus.

"Stem-pitting" virus, as described by Riley in *Commonwealth Phytopathological News* (Vol. 3, p. 29) was discovered in some Tanganyika varieties in a variety trial at Bvumbwe.

Extract from Report of the Entomologist

White Stem Borer (*Anthonus leuconotus* Pasc) continues to be kept in control by the use of Dieldrin. The Cameron bug (*Antestia variegata* Thumb) is beginning to become much more noticeable as the new plantings of coffee come into bearing. In Zomba as many as eighteen bugs per bush were found when spraying with Pyrethrum concentrate as a means towards assessing populations. In Cholo five bugs per bush could be found two weeks after a coffee plantation had been sprayed with Malathion. It is obvious that populations of this magnitude can cause severe damage to the crop and spraying against *Antestia* will be recommended during the coming season.

Coffee Leaf Miner (*Leucoptera coffeina* Washbourn) has occurred sporadically throughout the country. Observations confirm that this pest is usually only serious on coffee under heavy shade and hardly occurs at all on unshaded coffee. Where the attacks are severe a good deal of leaf shedding occurs.

Extract from Report of the Agricultural Chemist, Bvumbwe

1. ZINC DEFICIENCY SYMPTOMS

In last year's report, reference was made to the appearance at the end of the dry season of deficiency symptoms which disappeared with the onset of the rains. Thus, like zinc deficiency on mature tung, the problem did not appear serious and was only apparent in times of physiological stress.

In a variety trial at Bumbwe Station, the deficiency became more pronounced on young coffee—and similar reports were received from the Northern Province. At Bvumbwe it was noted that extreme chlorosis was limited to certain varieties (Tanganyika) and the extreme case of zinc deficiency, i.e., bunching of the leaves, leaving short internodal distances, together with malformation of the leaf was also

noted. The zinc content of leaves from the more satisfactory coffee (Kenya) was 9.5 p.p.m., compared with 7.5 p.p.m. in markedly chlorotic leaf. From data available for arabica coffee, the level below which zinc deficiencies occur is about 10–11 p.p.m. It would appear therefore that as both leaves contain marginal amounts of zinc, the varieties themselves differ in their susceptibility to zinc deficiency, probably due to their varying suitability for the climatic conditions and their reaction to cold. These samples were taken in the dry season, and are generally lower than figures of 12–20 p.p.m. obtained at other times of the year.

The full composition of these leaves was as follows, the samples being taken in February:

	Al	B	Cu	Fe	Mn	Mo	Zn
Normal (Kenya varieties) p.p.m.	160	95	15.6	90	170	0.08	9.5
Chlorotic (Tanganyika) p.p.m.	140	110	13.0	70	140	0.07	7.5

The possibility of edge scorch being due to potash deficiency was considered, but in view of the high potassium status of the soils this could hardly be suspected. Typical scorched leaf was found to contain 2.4–3.2 per cent. K, the content of normal green leaf being less at 1.4–2.2 per cent.

In the Northern Province, extreme chlorosis was first reported from the Misuku area, especially under acid soil conditions. The zinc content of coffee leaves decreased from 20 to 15 to 6 p.p.m. in areas where the soil pH dropped from 5.8 to 5.4 to 5.0.

A soil application of zinc sulphate on the Misuku coffee produced a marked improvement in the appearance of the leaf, although this was not reflected in the composition of the leaves (taken to test the effect of sulphate of ammonia and apparently before the full effect of the zinc had occurred).

TABLE V
Major and Micro Nutrient Determinations on Coffee Leaves from Misuku

<i>Plot Treatment</i>	N	P	K <i>per cent.</i>	Ca	Mg	B	Cu <i>p.p.m.</i>	Fe	Mn	Zn
S/A nil	2.53	.18	1.47	.99	.27	45	5.6	140	250	20.3
S/A 2 oz.	2.62	.16	1.53	.78	.33	27	10.8	125	280	24.5
S/A 4 oz.	2.60	.14	1.46	.89	.23	23	13.3	110	395	21.1
+ Zinc Sulphate	2.32	.13	1.43	.88	.34	140	3.8	155	220	15.4

The samples do not show the marked differences that were present in the leaves examined originally (results given in last year's report). The nitrogen status in the control leaves is little different from that on which ammonium sulphate has been applied. As the manganese and zinc contents are about the same it does not appear that the application of ammonium sulphate had such an adverse effect on the pH of the soil as occurred originally. Both this factor and the similarity in N content would appear to be confirmed by the more uniform general appearance of all the leaves submitted.

A more detailed examination of samples from some parts of the Northern Province was made in late May. Full details for the leaf samples taken from Lusangazi, Mhowe, Nchenachena, Junju and Usamaras are given below in Table VI.

TABLE VI
Micronutrient Determinations on Coffee Leaves

Lab. Ref. No.	Details of Sample				Al	B	Cu	Fe	Mn	Zn
							<i>p.p.m.</i>			
	<i>Lusangazi</i>									
773	Satisfactory	..	..	..	390	50	7.2	130	96.0	13.3
774	Chlorotic 1	..	..	..	330	80	3.0	140	80.0	7.0
775	Chlorotic 2	..	..	..	430	72	6.6	170	92.0	7.2
	<i>Mbowe Seedling Coffee</i>									
776	0 Zn, 0 Shade	..	..	..	370	71	5.8	190	130	9.2
777	0 Zn, + Shade	..	..	..	560	75	10.0	160	190	24.7
778	+ Zn, 0 Shade (Av. leaves)	..	..	..	460	85	4.9	140	180	65.0
779	+ Zn, 0 Shade (Very poor leaves)	..	..	..	710	70	10.0	220	220	52.4
780	+ Zn, + Shade	..	..	..	600	59	10.0	170	100	43.0
	<i>Mbowe Coffee Under Tung</i>									
782	Not Sprayed—but green bushes	..	..	..	200	55	8.3	80.3	370	11.0
1	" " Chlorotic bushes	..	..	..	210	65	7.9	86.0	320	8.2
3	+ Zn ..	..	..	..	260	57	13.8	88.0	240	21.6
	<i>Nchenachena</i>									
785	Green leaves	..	..	..	220	57	5.9	100	160	7.8
4	Chlorotic ..	..	..	..	160	71	5.2	80.0	140	9.2
	<i>Junju</i>									
786	Chlorotic ..	..	..	..	410	57	15.2	150	30.0	5.4
	<i>Usamaras</i>									
787	Satisfactory	..	..	..	210	56	10.5	100	52.0	8.2

Examination of these figures indicate that for aluminium, boron, iron and manganese figures fall within the range generally reported as satisfactory, and there is no firm variation of these elements with the incidence of chlorosis. The higher manganese content of the Mbowe leaves appears to be associated with the higher acidity of Mbowe soils (pH5-5.4), when compared with Lusangazi, Junju, and Usamaras (pH5.5-5.8). It is also significant that among tung at Mbowe (where the use of ammonium sulphate will further have reduced the pH), the manganese is higher still.

Some of the copper contents are below the level of 9 p.p.m. which has been generally reported as the minimum for *arabica* coffee—although other figures as low as 3 p.p.m. have been quoted. At Lusangazi, the chlorotic leaves contain less copper and zinc than do the green leaves, although the difference in copper content is not so pronounced in sample 775.

In 1957, samples of leaf taken from the Vipya Tung Estates and suspected of showing boron and zinc deficiency, gave no evidence of the former, but the healthy green leaf contained 15 p.p.m., and the chlorotic leaf 8 p.p.m. Zn. It was therefore suggested that zinc spraying could be tried.

In the area of young coffee at Mbowe, samples were taken in May, 1958, from the range of zinc and shade combinations. Without any shade, the young plants had small chlorotic leaves, which contained only 9 p.p.m. zinc. Where small plants had been protected by hessian, the leaves were green and showed normal development—although it was very significant that immediately the plant protruded above the hessian shield, the leaves again became chlorotic. The zinc content of the green leaves was higher, i.e. 24 p.p.m. Where zinc had been applied without hessian protection to the plant, the zinc content was greatly increased—although chlorosis still existed. Two samples of leaves were taken from this plot, and although their zinc content was similar, the extent of the chlorosis differed appreciably. Where zinc had been applied in conjunction with shade (No. 780), the leaves were uniformly

green although the zinc content was slightly lower than in 778 and 779. This may have been caused by more luxuriant vegetative growth on the protected plant. The general impression was that the hessian had caused a bigger improvement, than had the zinc spraying itself.

In the older coffee under tung shade at Mbowe, there were several rows of unsprayed bushes to be compared with zinc sprayed ones. In the unsprayed rows, it was noted that there were bushes which were showing no chlorotic symptoms, alongside those that were. Generally, the good bushes appeared to be immediately near tung trees, or where the tung trees were rather more vigorous. Whether this was due to increased protection, shade, or fertility is not clear, but the zinc content of the leaves from such bushes (11 p.p.m.), was higher than in the affected leaves (8 p.p.m.). Where zinc had been applied the rows were uniformly green, and the content of the leaves was 22 p.p.m.

At Nchenachena, the chlorotic leaves contained slightly more zinc than did the satisfactory leaves. As the latter came from a row treated with dung and N.P.K., some other nutrient factor may be involved, or the much heavier leaf growth in this guard row may itself have provided some protection. The copper content was also rather lower at Nchenachena. The nitrogen, at 3.1 per cent., was the same in chlorotic and green leaves.

At Junju, in a very exposed area on top of a hill, the incidence of chlorosis was high, and zinc content was low at 5 p.p.m., this is definitely in the accepted deficiencies range. But at Usamaras in coffee over ten years old, where growth was completely satisfactory and no sign of chlorosis occurred, the zinc content of the leaf was only 8 p.p.m., i.e. what one would assess as being in the deficiency range. However, this particular coffee was in an extremely well protected valley head, and the soil was rich in organic matter. This latter point may be related to the observations at Nchenachena, i.e. good green leaves of rather less zinc content than chlorotic ones, from trees on soil to which dung was added.

CONCLUSIONS

It therefore appears that while there is a tendency towards zinc deficiency in Nyasaland coffee, especially in younger plants, the incidence of such symptoms is very much related to shade and shelter. "Hot and cold" symptoms will appear under conditions of exposure, but the degree to which zinc is present or absent will markedly modify these symptoms. Thus in the absence of zinc they become aggravated. In this connection it may be noted that American observations on tung have shown that a zinc content of 200 p.p.m. is necessary in the leaf to prevent cold injury, whereas the normal level to prevent appearance of deficiency symptoms alone is only 50 p.p.m. Similar kinds of observations on variation of zinc content with climatic conditions have been made on maize in California and on clover in Australia. Also, flax plants showing zinc deficiency symptoms in winter have been observed to recover in the spring.

2. FUSARIUM INVESTIGATIONS

To obtain further data on coffee leaf composition to compare with the Cholo bushes affected by *Fusarium* disease, as detailed in last year's report, the composition of representative leaves from Bvumbwe coffee was found to be as follows. The samples were taken in October.

			N	P	K	Percent.						p.p.m.			
						Cu	Mg	Al	B	Cu	Fe	Mn	Zn		
Mature leaf	..	..	1.55	0.10	1.95	.67	.40	75	70	26	230	155	14.8		
Young leaf	..	..	3.10	0.15	2.28	.91	.42	76	52	31	170	135	9.2		

Compared with the Cholo coffees, the N.P.Ca.Mg are rather lower, but the potash is the same. The copper, zinc and boron contents are of the same order, but the manganese and iron are rather higher. But again, there appears little evidence to relate the nutrient status of the coffee to the incidence of *Fusarium* disease.

3. PREMATURE LEAF FALL

Analysis of leaves from various areas of coffee showing leaf fall or scorching were made. Coupled with field observations, the main fault appeared to be planting on unsuitable sites or to water stresses.

FRUIT

Strawberries

VARIETY TRIALS

The trial with seven varieties described in last year's Report cropped over a period of six months, from early in July to the end of December. There were two main peaks of fruit production, early August to mid-September and mid-October to mid-November. C449 was the first variety to come into bearing and reached its peak by the 20th August; Early Pine followed about a fortnight later. Results of the yields for the full season are given in Table I below.

TABLE I
Strawberry Yields, 1957

Variety	Short tons per acre
Cambridge Early Pine	6.36
Cambridge 449	5.75
Nankhunda	4.56
Melba	4.11
Katete	2.40
Salisbury	2.10
Vumba	2.04
Mean	3.90
L.S.D. $P=0.05$	0.67
$P=0.01$	0.90
Coefficient of variation	15.7%

Higher yields were obtained than in previous trials by adopting closer spacing, employing a higher irrigation rate and by planting early. Spacing was in double rows of 9" x 18" at 36" apart giving a plant population of 25,813 to the acre. The irrigation rate was 0.6" per acre at each watering, delivered by an overhead sprinkler system. Soil moisture was maintained at above half field capacity. Planting was done early in March and the plants were deblossomed until 1st June.

Those varieties which made the most growth in the first two months were the best yielders. The size of fruit decreased as the cropping period came to an end, a good average size being about 4 gm.

The newly-imported varieties Cambridge Early Pine, Cambridge 449 and Melba were more resistant to leaf spot, *Mycosphaerella fragariae*, than local varieties.

A further trial of the four best varieties and a promising local variety was planted at the end of March in 1958; this was later than usual. Growth measurements were taken in June. Fruit production for the current season has not finished at the time of writing but has been recorded to a point between the two normal production peaks representing 60-62 per cent. of the potential.

TABLE II
Strawberries, 1958

Variety				Spread in Dcm.	Yield in short tons 8-7-58 to 27-10-58
Early Pine	..	..	..	2.08	1.60
Melba	..	..	..	1.85	1.53
Nankhunda	..	..	..	1.72	1.57
Cambridge 449	..	..	..	1.56	1.50
Gaymead	..	..	..	1.52	0.78
L.S.D. P=0.01	..	..	..	0.03	0.43
P=0.05	..	..	..	—	0.31
Coefficient of variation	..	..	..	14.3%	16.05%

Table II shows that growth made in the early part of the season is again correlated to the crop to follow. Basing the yields as 60 per cent. of the potential, the total expected crop could be reckoned as ranging from 1.30 to 2.67 tons per acre. This is lower than last year due to the much later planting date. Early Pine still remained the best yielder and all four varieties from last year's trial were better croppers than the local variety "Gaymead"; Gaymead was not any more resistant to leaf spot than other local varieties.

MANURIAL/IRRIGATION EXPERIMENTS

A factorial experiment was planted early in March, 1957, with the varieties Cambridge 449 and Melba to obtain information on the response of strawberries to manures and to different rates of irrigation. The experiment was to run for two years to demonstrate whether it was possible to obtain a reasonable crop in the second year. Spacing was in double rows of 18"×18" at 36" apart giving a plant population of 15,488 to the acre. The irrigation rates were for each watering $\frac{1}{8}$ " per acre and $\frac{2}{8}$ " per acre in 1957 and $\frac{1}{2}$ " per acre and $\frac{3}{8}$ " per acre respectively in 1958. Time of irrigation was determined with the aid of gypsum blocks at depths of 9" and 18", and at all times the soil moisture was maintained at above half field capacity.

Growth measurements taken in May, two months after planting, showed no significant response to any fertilizer, probably because the site had previously been dunged at the rate of about 10 tons per acre. However, plots to which superphosphate had been added at the rate of 4 cwt. per acre consistently produced bigger plants particularly in the variety Melba. Melba produced larger plants than C449. By November growth in the higher irrigated plots was significantly greater than all other treatments. Sulphate of ammonia at 2 cwt. per acre in split dressings (half in early April and half in August) was then producing a slightly bigger plant than superphosphate. Melba responded better than C449 to both fertilizer and irrigation.

A series of side plots was not irrigated. At the end of the dry season there were many vacancies in all these plots no matter what the fertilizer treatment; Melba had a survival rate of only 16 per cent. and C449 of 33 per cent.

Yield figures are available for the 1957 season and part of the 1958 season (representing 60-62 per cent. of the crop); on this basis the mean for 1958 can be expected to be in the region of 3.41 tons (see Tables III and IV below).

TABLE III
Strawberry Experiment
Response to Manures and Irrigation (Short tons per acre)

Year			Experimental mean	Increase in Yield due to			L.S.D. P=0.05	Coeff. of var.
				Nitrogen (N)	Phosphate (P)	High irrigation (I)		
1957 ..	..	..	3.70	0.07	0.09	0.42	0.13	10%
1958 *	..	..	2.05	0.14	0.07	0.03	0.09	22%

* Part of crop only; estimated to be 60 per cent. of total.

TABLE IV
Difference between Varieties
(Short tons per acre)

Variety				C449	Melba	Mean	L S.D.	
							P=0.05	P=0.01
1957 ..	..	..	..	4.42	2.98	3.70	0.21	0.29
1958 Recorded	..	..	..	2.69	1.40	2.05	0.12	0.16
Expected	..	..	..	4.48	2.33	3.41	—	—

The first year's results demonstrate the need for irrigation and show that the plants were able to make use of more water than provided by the lower rate. The higher rate of irrigation produced a greater increase in crop than any fertilizer treatment. Twenty-four applications of water were made between July and November; this amounted to an equivalent of 177,750 gallons per acre at the low rate and 355,500 gallons per acre at the high rate. There appeared to be some gain from a top dressing of superphosphate at planting time. The lower plant population (compare with variety trial for 1957) has resulted in a considerably lower overall yield.

In the second year a top dressing of nitrogen was beneficial. Increasing the lower rate of irrigation to $\frac{1}{2}$ " per acre led to an increase in yield. The overall yield in the second year is expected to show a decrease. The plants were slow to come into bearing in the second season and the size of the leaves, even from runners, has decreased. The size of the fruit has also decreased. There is therefore some justification for the belief that strawberries in the tropics are best grown in a new bed each year from newly-produced runners.

Other Fruits

The 1957 yields of peaches and plums at Bvumbwe were satisfactory. But the crop which has been set for 1958 is a small one since the trees lost many flower buds as a result of a hot dry spell in March. Plums responded again to a spray of D.N.O.C.

It is doubtful if large-scale commercial plantings of deciduous fruits are justified on the Shire Highlands; they will however crop reasonably enough for household use. Yields at Mwera Hill and Nchenachena were more satisfactory (see Table V below).

TABLE V
Yields of Deciduous Fruits, 1957 (lb.)

Variety	Nchenachena			Mwera Hill		
	Yield per tree	6-year mean	Yield per acre	Yield per tree	6-year mean	Yield per acre
Peach, Angel	88	48	5,230	31	41	4,470
„ Kiliekrankie	28	70	7,630	21	25	2,730
„ Waldo	208	156	17,000	30	50	5,450
Plum, Santa Rosa	13	26	2,830	39	50	5,450
„ Satsuma	30	34	3,710	17	11	1,200

Yield per acre calculated on spacing of 20' x 20' or 109 plants per acre.

Other fruits which have produced good crops at Bvumbwe are guavas, loquats, tree tomatoes and mulberries. Queensland nuts and persimmons are also promising and new varieties have been imported.

Yields of Fruit at Bvumbwe

	Age years	lb. per tree	lb. per acre*
Guava Parkers White	4	287	31,283
„ Patnagola	4	205	22,345
„ Keerweder	2-3	138	15,042
Mulberry	3-4	67	7,303
Loquat	4	53	5,777
Red tree tomatoes	3	48	23,760
Yellow tree tomatoes *	3	35	17,320

* Calculated on a population of 109 trees per acre except tree tomatoes, which were at 495 trees per acre.

A considerable number of guavas were lost due to false codling moth and attacks of fruit fly. The question of fruit fly attacks is being investigated further. Mosquito bug, which disfigures the fruit and foliage and causes dieback of the growing tops, was satisfactorily controlled by spraying with D.D.T. Some trouble was experienced with branches of mulberries breaking under the weight of the crop. Loquats were damaged by a beetle which was controlled by a D.D.T. spray.

Peach leaf curl (*Taphrina deformans*) occurred in the early part of the growing season and was quickly controlled with a copper spray, which also controlled attacks of shot hole fungus. Leaf rust (*Puccinia pruni-spinosae*) was however serious at the end of the rains and its control needs further investigation. In spite of the fact that the indigenous trees in the field were ringbarked and allowed to die before removal, attacks of *Armillaria* Honey Fungus are occurring and there have been a few casualties among peaches.

Propagation of fruit varieties continues but the range is not being extended until observations have proceeded further. Avocadoes are undoubtedly suited to the Bvumbwe climate and means of propagating them vegetatively have been investigated. Budding has not proved as successful as grafting. Both saddle and veneer grafts were used. The scion, bearing three to four buds, had previously been chilled for a fortnight and any which lost their buds rejected. There was not any difference between the success of saddle or veneer grafts but the saddle graft would appear to produce a plant less liable to suffer from wind damage. A new type of plastic tape was used and it gave very satisfactory results. It has been adopted for use on all budding and grafting.

Stoolbeds have been established of quince, marianna plum and apple rootstocks. A high percentage of rooting has been obtained with the apples and quinces but results with marianna plum have been variable. All beds gave too great proportion of large-stemmed stocks (over 10 mm. diameter), too large for working. Extension growth made in the season was excessive, suggesting that the conditions at Bvumbwe are too forcing.

Irrigation studies continue with peaches, plum, apricots and tung.

Extract from Report of the Agricultural Chemist, Bvumbwe

CITRUS

The observational experiment, using nitrogen, referred to in last year's report, has continued. The uniformity figures were rather variable, and thus it may take a few seasons for marked effects to be apparent. However it was noteworthy that the fruit on the higher N plots were bigger and showed a markedly less tendency to browning of the skin. Representative leaf samples were taken, and where the higher amounts of nitrogen had been applied, (i.e., 5 lb. ammonium sulphate per tree, with and without 150 lb. cattle manure) the nitrogen content of the normal leaf was 2.6-3.1 per cent. compared with 2-2.2 per cent. on the chlorotic leaf of the control plots. It should however be noted that there was an overall dressing of about 100 lb. of cattle manure over the whole experiment. Comparison of the higher N plots with the chlorotic leaves reported last year, i.e., where no fertilizer had been applied and the N content was about 1.5 per cent., is therefore of more significance.

APPLE

(a) Apple leaf from trees at Bvumbwe cut back at different times showed the following composition:

				Al	B	Cu	Fe	Mn	Zn	Mo	
I	Pruned	July	.. ..	270	120	13.7	110	130	37.0	.47	p.p.m.
II	..	October	.. ..	715	—	26.0	460	62	27.7	.33	p.p.m.

The II leaves were much smaller than I. The higher amounts of iron and aluminium would suggest an accumulative effect due to small growth, but this is not reflected in the other elements.

(b) Sample of leaves from Mwera Hill, showing edge scorch symptoms which might be due to magnesium deficiency, were found to contain 0.21 per cent. magnesium compared with 0.31 per cent. in good leaf from the same trees. The upper figure would appear satisfactory, and the lower figure marginal when assessed by comparative data from temperate apple leaf. It was also noted that the nitrogen figures differed, being 1.7 per cent. in the scorched leaf and 2.3 per cent. in the green leaf. Both these figures would appear low, based on the composition of leaf in temperate areas, and the problem would appear to be one of marginal nitrogen supplies.

Extract from Report of the Plant Pathologist

BANANAS

Cercospora musae Zimm. has again been discovered in Nkata Bay District, not very far from where it was first discovered two years ago. It is thought that it is unlikely to spread from this district, owing to its isolation by high mountains, and the fact that this particular part of the country is the only one which has a climate comparable to that of the humid tropics.

ORNAMENTALS

Carnations. *Uromyces caryophyllinus* developed on some carnations imported from Holland through Southern Rhodesia. It is hoped that prompt action taken when the disease was first discovered has prevented the outbreak spreading.

IRRIGATION

The Irrigation Project

INTRODUCTION

Plans for a pilot irrigation project at Makanga were drawn up in 1953, and construction work was completed in December, 1954. The first irrigated crops were planted during the 1955 dry season. The severe flood in April, 1956, destroyed the 1955/56 crops, damaged the irrigation channels and silted up the pump and river intake; no dry season cropping was possible.

An improved water supply was installed during 1956/57, and the original plan was extended to include about ten acres of newly acquired land above the 1952 flood level.

The objects of the scheme are:

- (1) to obtain information on the yields to be expected from as wide a range of crop as possible;
- (2) to ascertain the water requirements of the main crops being grown;
- (3) to investigate different methods of applying irrigation water to the land.

Irrigation Methods

Basin irrigation has been adopted as the standard method for experimental work, as it appears to be the best adapted to the measurement of water applied. The basins measure 10 yds. $\times$ 15 yds. (1/32 acres); the standard watering is 2 inches per application, applied at a rate of 0.5 to 1.2 cusecs.; water measurement is by 90-degree triangular weir or by free-flowing rectangular orifice—the latter is more restricted in range, but gives a more accurate measurement at the rates of flow required.

Furrow irrigation by syphon tubes was used originally, but it is difficult to measure water accurately on to small plots by this method.

Rotations

Nine fields, each of just over one acre, are divided into two groups of three and six respectively, to give the following rotations:

Group I (3 years)		Group II (6 years)	
<i>Wet season</i>	<i>Dry season</i>	<i>Wet season</i>	<i>Dry season</i>
Cotton	—	Cotton	—
—	Beans	—	Beans
Maize	—	Maize	—
—	Linseed	—	Linseed
Soya	—	Soya	—
—	Wheat	—	Wheat
—	—	Cotton	—
—	—	—	Lucerne
—	—	Lucerne	—
—	—	—	Lucerne
—	—	Lucerne	—
—	—	—	Lucerne

These rotations will be modified in the light of experience; already an alternative to linseed is being sought. The most troublesome crop to fit in is cotton, which may be on the ground until 31st July, a very late start for the following dry season crop.

Sugar cane, citrus and cocoa are being grown on a field scale, in addition to the annual crops in the rotations.

MANURING

The intensive cropping in Group I (Fields A, B, and C) may lead to depletion in soil fertility. A check on this is provided by long-term manurial trials laid out on each field, where nitrogen, phosphate, potash and cattle manure are applied to specific crops in the rotation; Group II receives no manure.

Crops and Yields

The first objective is to find the most suitable crops to grow under irrigation; Table I summarizes the results of the past year. In order to meet the capital cost of an irrigation project, not only good yields but high value per acre are important, and an attempt has been made to assess the comparative value of each crop. This is beset with difficulties; little is known as yet of costs of production, and gross value only is given; prices are as near as possible those obtainable in the Federation, but fluctuations make these difficult to determine; prices for perishable products depend on an adequate market and/or facilities for preservation such as a canning factory, and price fluctuations of primary products cannot be foreseen. With all these reservations, the values quoted give a fair idea of which crops are most likely to be profitable.

TABLE I
Comparative Value of Irrigated Crops

Crop					Acres	Yield/acre	Value	Value/acre
<i>Dry season 1957</i>								
Linseed	..	..	..	..	.65	486 lb.	£50 per ton	£12
Wheat	..	..	..	..	.87	1,044 lb.	£30 per ton	£16
Maize	..	..	..	..	.18	2,550 lb.	1d per lb.	£10
Red beans	..	..	..	..	.93	Failed	£30 per ton	—
Beetroot	..	..	..	..	.04	10.5 tons	£8 per ton	£84
Carrots	..	..	..	..	.18	8.7 tons	£8 per ton	£70
Onions	..	..	..	..	.15	12.1 tons	3d per lb.	£300
Potatoes	..	..	..	..	.07	5.6 tons	2d per lb.	£93
Lucerne meal	..	..	..	..	.91	3 tons	£7 per ton	£21
Sugar	..	..	..	..	.60	5 tons	£50 per ton	£250
						(estimated)		
<i>Wet season 1957-58</i>								
Cotton	..	..	..	..	1.00	1,100 lb.	6d per lb.	£30
						275 lb.	2d per lb.	
Maize	..	..	..	..	1.00	2,470 lb.	1d per lb.	£10
Soya beans	..	..	..	..	1.00	1,220 lb.	£30 per ton	£18
Lucerne meal	..	..	..	..	.91	4 tons	£7 per ton	£28
Hibiscus fibre	..	..	..	..	.10	1,800 lb.	£40 per ton	£36
Sunn hemp fibre	..	..	..	..	.10	Failed	£40 per ton	—

Dry Season Crops—1957

WHEAT

The Federal Government is anxious to increase to domestic production of wheat, as it is one of the largest imports. Four varieties were tested in a yield trial. Sabonera is the variety grown locally in the Kirk Range at around 5,000 feet above sea level; at Makanga, its growth was rank, the crop lodged badly and the yield was low. There was no significant difference between the yields of the other three varieties, obtained from the Sabi Valley in Southern Rhodesia (Table II).

TABLE II
Wheat Variety Trial
Makanga—Irrigation N—Trial 7/22

Variety				Yield of grain in lb per acre
Sabonera	..	..	..	220
Kenya Governor (?)	..	..	..	1,080
Kenya 261 R7C	..	..	..	986
Angola XZ—50	..	..	..	1,002
Significant Difference (P=0.05)				309
S.E.				±102.8
Coefficient of variation				31%

Plot size 1/258 acres. 6 replications of 4 varieties. Seed rate 100 lb. per acre, drills 7½". Planted 3rd May, 1957.

Three dates of planting, ranging from 15th April to 17th May, all gave very similar yields. The variety planted was the one described as Kenya Governor in Table II; it resembles this variety, but contains a mixture of types.

LINSEED

The crop appeared to grow well in spite of a rather poor initial stand, but the final yield was too low to be economic.

PHASEOLUS BEANS

Canadian Wonder beans were severely attacked by a stem-boring fly (*Melanagromyza phaseoli* Coq.) at the end of August; practically every plant died within a few weeks, and no crop was reaped.

VEGETABLES

Vegetable crops do well in the dry season, and have a high value per acre even when high labour requirements are taken into account. The types grown were chosen for ease of handling and sufficient keeping quality to allow for transport by train to Limbe and Blantyre; most other European vegetables have been grown successfully as garden crops in the dry season.

Onions are the most satisfactory in that they can be stored for upwards of three months. The large white varieties (Texas Grano and Early Cape Flat) are, however, not suitable for canning; one of the small red varieties will be tried next year.

Wet Season Crops 1957/58

COTTON

Cotton has so far been grown only during the wet season, because of the danger of building up red bollworm populations if it is grown throughout the year. Under large-scale irrigation, it would be possible to grow cotton as a dry-season crop. This is done in northern Nyasaland, and the crop is very free from pests, but it must be emphasized that both systems cannot be permitted in the same area.

Early planting of cotton is at present limited by the onset of the rains, but with irrigation it is possible to plant at any time. Trial 8/16 was designed to measure the effect on yield of very early planting. Cotton was planted in mid-October, mid-November and mid-December, the last planting coinciding with the first planting rains. The results were unexpected. The early planted cotton, even that receiving no irrigation after 15th December, grew 10 feet tall, little or no crop was set until

February—and then at the top of the plant. The plants were top-heavy, and blown into a tangled mass by wind and rain, so that it was practically impossible to get into the crop to pick it until the plants were uprooted at the end of the season. The November planted cotton gave the best yield, but at only 1,250 lb. per acre it was not significantly better than the other treatments (Fig. 7).

MAIZE

Planting before the start of the rains gave a small increase in yield, mainly because the December planting was heavily infected by rust (*Puccinia polysora*). Unreplicated plots of a resistant variety gave the same yield whether planted in October, November or December.

Closer spacing increased the number of cobs per plot, but this increase was nullified by a reduction in cob size.

SOYA BEANS

This crop gave an excellent yield in 1956/57—over 2,000 lb. per acre. In 1957/58 the germination was very poor; despite this the yield of 1,200 lb. per acre was quite satisfactory. In the dry season, grown alongside the crop of phaseolus beans, the soya was not attacked by the stem-boring fly.

FIBRES

A small area was planted with Kenaf (*Hibiscus cannabinus*) in December. 1,800 lb. per acre of retted fibre was obtained, which could probably be bettered by earlier planting. A similar plot of sunn hemp yielded only a small quantity of weak fibre.

Perennial Crops

LUCERNE

Mowing was not always possible at the proper time owing to pressure of other work, and the yields shown (Fig. 8) could be improved upon. In good weather, one or two days are sufficient for making hay; this is ground into meal in an ordinary hammer mill, and shows a high protein content (Table III). The price of £6 per ton is quoted in South Africa, but the London price is very much higher at £20 per ton.

TABLE III
Lucerne Meal

				per cent.
Moisture content	..	..	..	3.1
Oil and fatty matter	..	..	..	2.4
Crude protein	..	..	..	18.5
Fibre	..	..	..	28.4
Soluble carbohydrate	..	..	..	37.2
Ash, including:	..	..	..	10.4
Phosphate (P_2O_5)	..	..	..	0.6
Calcium (Ca)	..	..	..	1.3
Potash (K)	..	..	..	2.7
Magnesium (Mg)	..	..	..	0.4
Starch equivalent	..	..	..	66
Nutritive Ratio	..	..	..	1:2.4

SUGAR

Estimates for this crop are tentative, as they are derived from samples taken from a collection of 22 varieties, and no determination of sugar content has been made. The average yield of cane for all varieties was 53 tons per acre from the second cut, and sugar content has been taken as 10 per cent.

FIG. 3 — PICHE AND OPEN PAN
EVAPORATION

Open Pan
ins. per month

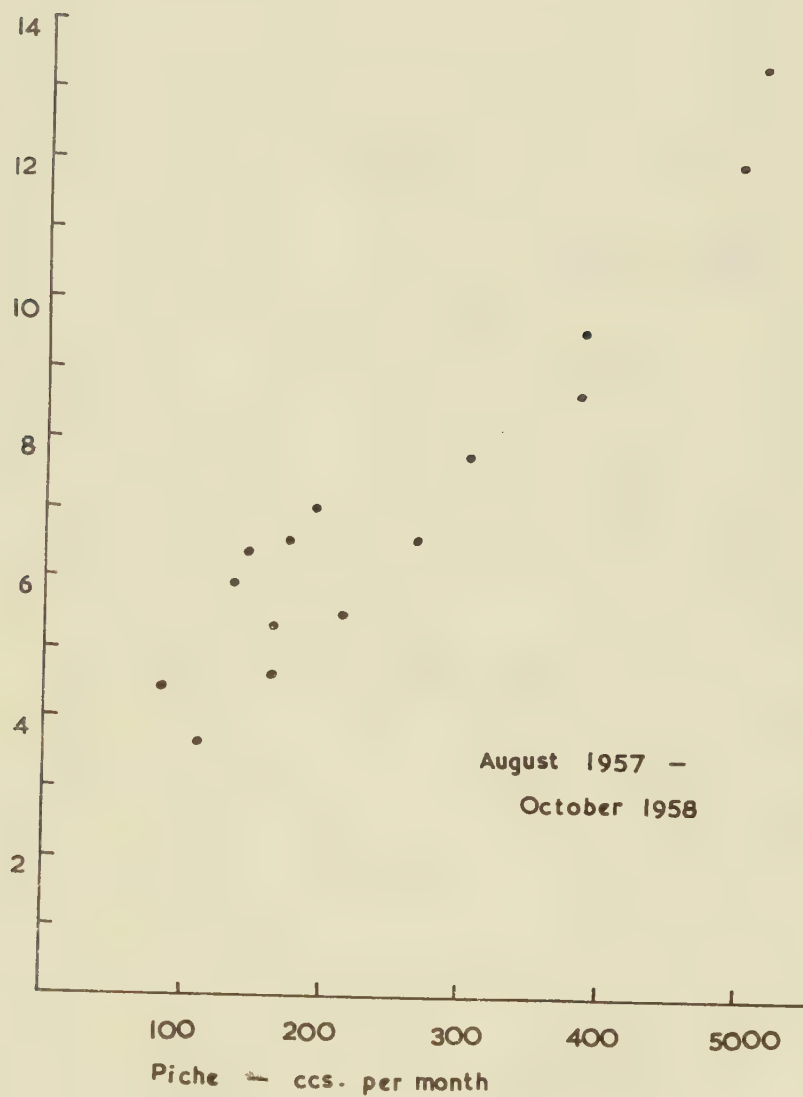


FIG. 4—LEAF AREA INDEX

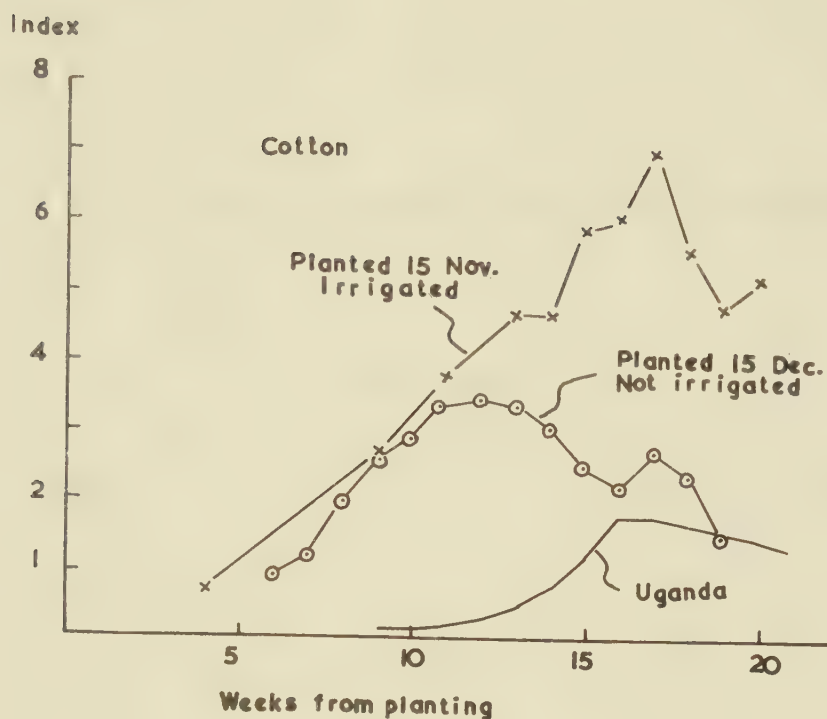


FIG. 5—LEAF AREA INDEX

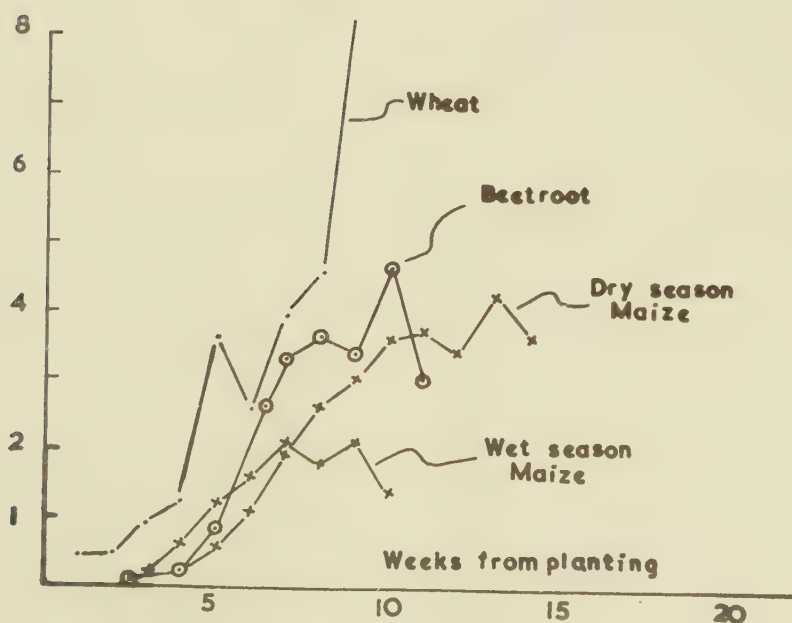


FIG. 6—MAKANGA IRRIGATION EXPERIMENTS

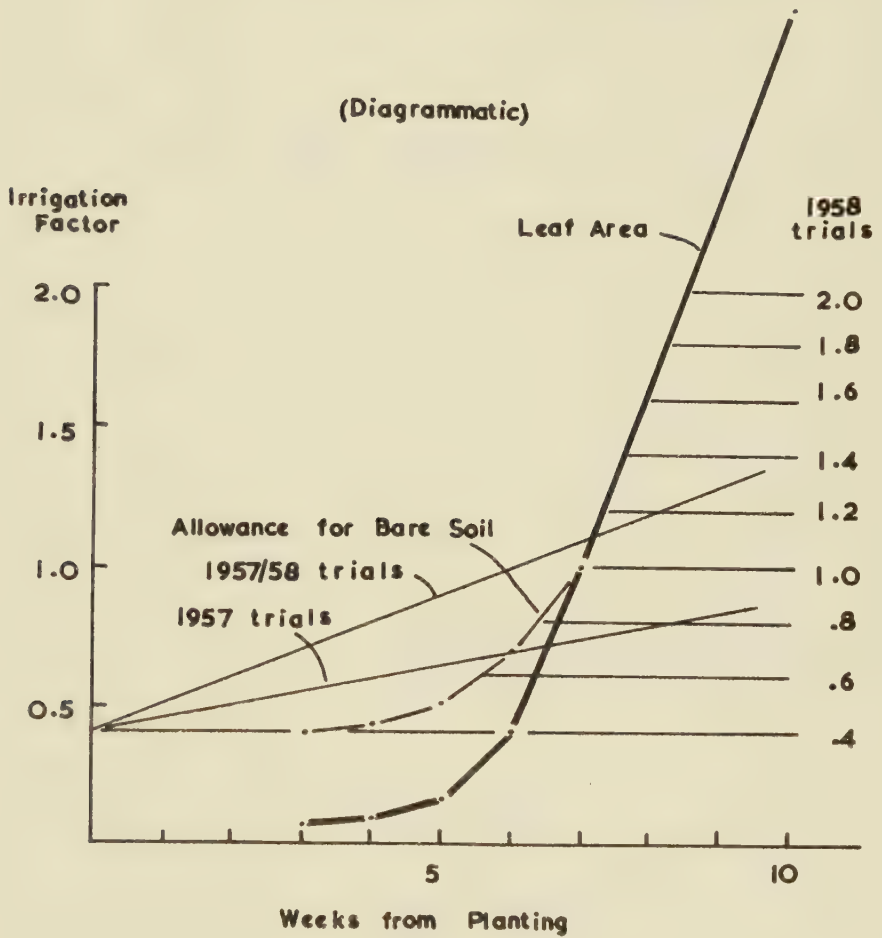


FIG. 7 — SEED COTTON YIELDS

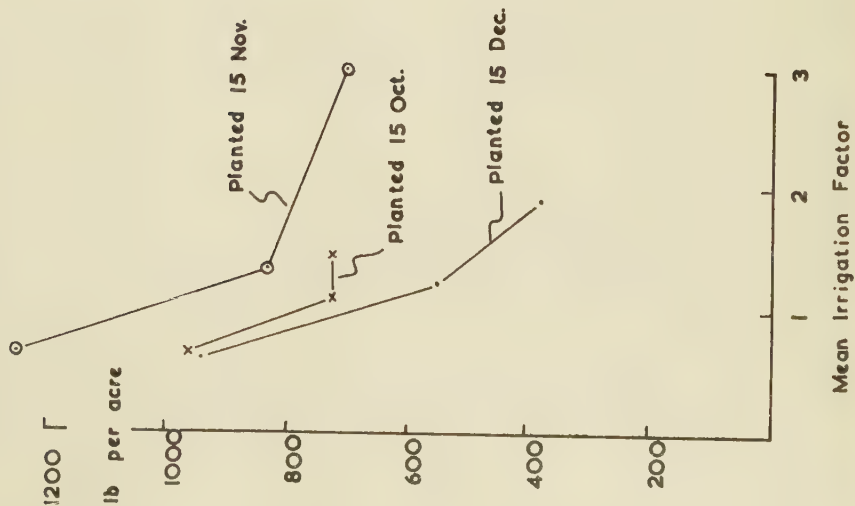


FIG. 8 — LUCERNE YIELDS

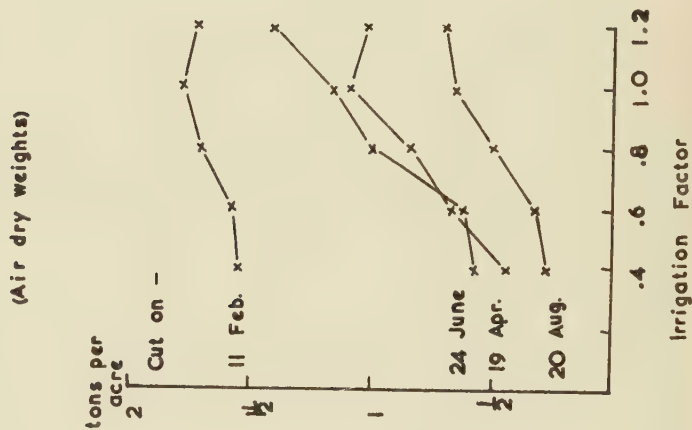
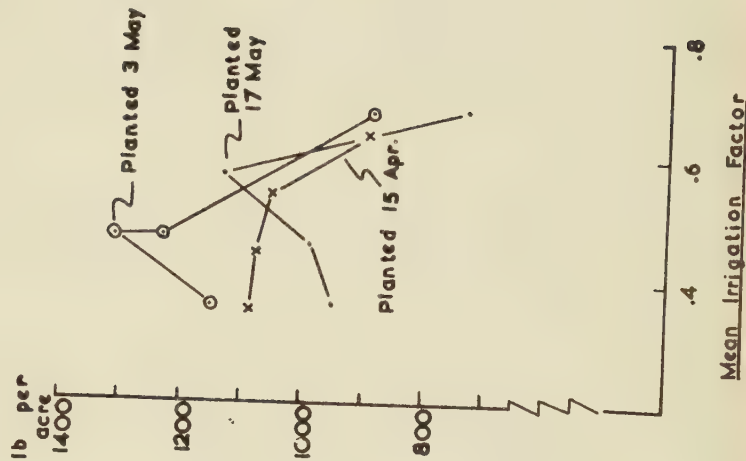


FIG. 9 — WHEAT YIELDS



COCOA

About half an acre of cocoa has been established under the shade of bananas. Seed was planted in December, 1957, in baskets and at stake in the field; the latter gave rather poorer germination, but many of the basket plants were checked or died when they were planted out. Direct planting in the field has given the strongest plants...

CITRUS

Two varieties of oranges have been planted in Field M. These will receive uniform watering until they come into bearing; planting has been arranged so that different irrigation rates can be applied later. There has been a considerable attack by scale insects on some of the young trees.

Crop Water Requirements

EXPERIMENTAL METHODS

Published figures for crop water requirements vary so widely that they are of little practical value in a country with little or no practical experience of irrigation. As a starting point, therefore, the irrigation experiments at Makanga have been based on the following assumptions:

1. Evapotranspiration is related to the evaporation measured by the open pan evaporimeter.
2. Evapotranspiration in a growing crop is related to leaf area of that crop.

In this report, the term "irrigation factor" means the ratio of irrigation water used to the open pan evaporation for same period, both measured in inches; and the "leaf area index" means the area of leaf lamina per unit area of land surface. Where not otherwise stated, an irrigation factor of 0.8 has been used.

MEASUREMENT OF EVAPORATION

The Water Development Department installed one of their standard open pan evaporimeters at Makanga in 1953, and the readings from this are used in the calculation of irrigation requirements. The pan is 48" in diameter and 16½" deep, with a gauging hook 3" from the top; it is mounted 5" above ground level and protected by a wire grid.

Since August, 1957, a pair of Piche evaporimeters have been recorded in the open near the pan. Monthly evaporation measured by the two methods is compared in Fig. 3; the open pan readings are rather higher in the wet season months December to April, but this is not entirely due to losses by rain splash. The April readings (6.58", 171.0 cc.) were made during dry weather (rainfall 0.18").

LEAF AREA MEASUREMENTS

Discs of known size were punched from fresh leaves, and the discs and leaves weighed immediately. An allowance (based on dissected samples) of 13 per cent. by weight is made for the leaf veins in cotton; similar allowance of 37 per cent. is made for the midribs in maize. This method allows a large number of samples to be handled quickly, and a high standard of accuracy is not essential for the present purpose.

Typical leaf area curves are shown in Figs. 4 and 5. The most striking feature is the difference between cotton leaf development here and in Uganda. The increase is much quicker, and a much higher leaf area index is reached, especially under

irrigation. It is probable that the relation between leaf area index and evapotranspiration demonstrated at Namulonge breaks down above 1.6, when available energy becomes the limiting factor. Current field experiments are designed to see when this point is reached for various crops. The design of these experiments is illustrated diagrammatically in Fig. 6; all treatments are watered according to the leaf area index, making an allowance for evaporation from bare soil, until the particular treatment index (=irrigation factor) is reached. This factor is then applied for the rest of the period of the experiment.

As all the crops measured reach an index of 1.0 in 5 to 7 weeks, it may well be that this preliminary stage could be omitted, and the final factor applied from the start; there would be little waste of water, and the calculation of irrigation requirements would be very much simplified.

Fig. 6 also illustrates the actual irrigation factors used in the 1957 dry season and the 1957/58 experiments, which were started before leaf area measurements had been made. In 1957 the irrigation factor was increased by 0.1 every two weeks, starting at 0.3; this approximates to the cotton leaf area index curve in Uganda. This rate of increase appeared to be too slow, as some crops ripened in three months, and in the 1957/58 season the factor was increased by 0.1 every week.

SOIL MOISTURE

Little work on soil moisture measurement has so far been attempted. A few gypsum blocks were installed under a maize crop in the 1957 season, but readings were made at rather irregular intervals. It was apparent, however, that irrigation of maize using a factor of 0.8 allowed soil moisture in the top four feet of soil to fall nearly to wilting point.

The Agricultural Chemist, Chitedze, has installed a series of gypsum blocks in each irrigation basin in Field L, to measure the changes in soil moisture at 1 ft., 2 ft. and 4 ft. Regular readings are now being taken under a maize crop receiving different rates of irrigation; this field will be planted with the six different crops in the rotation during the next three years.

COTTON

The excessive vegetative growth of cotton when planted before the rains has already been referred to. This type of growth has been seen in rain-grown cotton before in seasons of early rains at Makanga, and presents a serious problem. The examination of shed bolls and buds this year showed that only about one-third of the shedding was due to visible insect damage. Irrigation was not excessive by standards applied elsewhere—about 60 inches are applied in a season in the Sudan, and up to 70 inches in California—and in trial 8/16 the rainfall plus irrigation ranged from 16 inches to 100 inches; yet the lowest water rates gave the best yields (Fig. 7). Climatic factors other than rainfall are being studied (a correlation has been shown elsewhere between cloudy weather and boll shedding) and a wide range of different treatments will be tested in observation plots in the 1958/59 season, to see their effect on growth and shedding.

LUCERNE

The most positive results obtained so far have come from trial 7/18, where different irrigation rates have been applied to lucerne. This trial was planted in June, 1957. Up to December the treatments were calculated at 0.8 of the open pan evaporation, and different "planned monthly deficits" were allowed to accumulate. The highest irrigation rate gave the highest yield at the first cutting, but subsequently there was little difference between treatments. The later cuts were taken at the hottest and driest time of year, with open pan evaporation over 12 inches per month,

and it was realized that treatment differences of half an inch per month were relatively unimportant. From December onwards, a new set of treatments using factors ranging from 0.4 to 1.2, were introduced and it has been shown that the best yields are obtained with an irrigation factor of 1.0 to 1.2 (Fig. 8).

WHEAT

An interesting contrast is shown by wheat grown in the 1957 dry season. Here again the treatments differed in the planned monthly deficit, and the range was not very wide; but it was sufficient to show that the best yields are obtained with a mean factor of 0.4 to 0.6 (Fig. 9). This is all the more surprising as the leaf area index of wheat is the highest of any crop so far measured here, and the best yielding plots appeared to be short of water during the season as judged by colour and wilting.

MAIZE

The range of irrigation rates was too narrow to give much information. Further trials are being carried out in both dry and wet seasons, to give a comparison between the same irrigation factor applied under widely different evaporation conditions.

AGRICULTURAL CHEMISTRY AND SOIL PHYSICS

Report of the Agricultural Chemist, Bvumbwe

Most of the work in this branch is detailed under the headings of the various crops as follows: Maize and Other Cereals, p. 20; Oil Seeds, p. 30; Tobacco, p. 48; Pastures, p. 79; Tea, p. 103; Tung, p. 109; Coffee, p. 115; Fruit, p. 124.

Other problems and topics are however best dealt with as a whole, and these are outlined below.

1. MISCELLANEOUS

(a) FEEDING STUFFS, ETC.

The usual range of feeding stuffs were examined during the year, and the relevant data is summarized below, figures being on a dry weight basis.

		Ash	Oil	Protein	Fibre	Soluble Carbo-hydrates	Moisture as received
Rice Bran (ex Chiromo) ..	..	14.6	7.2	8.0	17.8	52.4	6.5
Chicken Food (maize basis) ..	..	1.8	4.3	9.8	1.9	82.1	11.2
Pigeon Pea Husks ..	..	5.4	5.7	11.3	35.6	42.4	8.3
Madeya (1) ..	..	4.0	11.9	11.1	7.6	64.9	11.5
" (2) ..	..	3.8	7.4	10.4	7.0	69.2	13.2
Cotton Seed Cake ..	..	7.3	7.3	44.2	9.5	28.0	5.2
Groundnut Cake ..	..	4.7	9.4	44.1	3.7	35.4	6.2
Soy Bean (Pelican) ..	..	—	22.9	41.9	—	—	13.5
" " (Volstate) ..	..	—	22.4	41.7	—	—	13.7
Jerne Hay (ex Makanga) ..	..	10.9	2.5	19.7	29.4	38.4	3.1
Russian Comfrey Hay ..	..	32.2	2.9	17.3	13.0	34.6	15.3

A sample of bone meal contained 75.5 per cent. calcium phosphate, and 6.8 per cent. protein. Fresh *Desmodium intortum* contained 33 per cent. protein, on a dry weight basis.

(b) COMPOSTS

Night soil compost from the Township areas contained .7 per cent. N, .4 per cent. P, and .8 per cent. K, the organic matter content being 10.8 per cent. sawdust composts made from cattle manure, contained from 0.3–0.9 per cent. N, 0.5–0.8 per cent. P and 0.2–0.5 per cent. K, with organic matter content of 4–10 per cent.

(c) Milk samples from the increasing herd at Bvumbwe have been examined through the year, daily butter fat averages of 4.5–6.0 per cent., being maintained.

2. WATER SUPPLIES

WATER ANALYSES

(i) Water samples from the Mudi River Water Board were checked during the year and, in connection with extension of water supplies to the Limbe-Blantyre area, samples from the Nankhunda stream (for Soche township) and streams of Mlanje Mountain and also the Shire River were examined. In all instances the waters were quite satisfactory and potable.

(ii) Privately submitted water samples from boreholes were examined for irrigation projects—and also for domestic use. In the latter case, the problem is usually one of suspended iron deposits from lateritic soils. The addition of small quantities of lime to the water, with subsequent settling, has been found effective.

3. SOILS AND NUTRIENT STUDIES—GENERAL INVESTIGATIONS

AVAILABLE PHOSPHATE ASSESSMENT

In order to compare the various methods of phosphate extraction from soils, a range of soils of pH 4.5–8.0 were examined, in order to compare the methods used here with those of Southern Rhodesia. The latter soils are usually of pH 6.0–6.6, and good correlations with fertilizer responses have been obtained by using sodium hydroxide extracts. Nyasaland soils, with higher rainfall, are rather more acid (pH 5.0–6.5), and ammonium fluoride extractions of phosphate have been used.

The comparative data is given on Table I.

One interesting outcome is the very similar figures obtained for water, Truog and HCl extracts, on Nos. 2, 4, 7, 8, 12, 14, 15 and 19. In the case of 4, 7, 8, 12, 15, the ammonium fluoride figures are also very close to these extracts. Although these soils cover the full pH range, it is noted that where this agreement occurs, the P determined is usually low. On the other hand, where the P values are high by any one method, e.g., 9, 10, 11, 13, 17, the spread of values is very much wider. The spread does not appear to be related to textures, and in this connection it may be noted that the soils mainly contain kaolinitic clays, except for Nos. 10, 13, 16, 18 and 19, which are from the Shire Valley and thus the clay fraction is montmorillonitic.

The general conclusion is that ammonium fluoride extracts may be more applicable to Nyasaland soils, which are generally more acid than are Southern Rhodesia soils. The difficulty would appear to be that our soils generally show little response to phosphate. Though on the basis of Birch's work soils Nos. 4 and 7 would be considered low in P, the NaOH (hot extractable P) all come above the figure of 50–55, which is about the top of the yield response curve obtained in Southern Rhodesia. Only No. 19 has a lower hot NaOH figure and here the figure is markedly lower than that obtained with cold NaOH. This soil is however moderately calcareous (*c.* 2 per cent. carbonate). The higher water soluble phosphate content of this soil is noted, although it is not easy to see why this should be higher than the soda extracts, since any soluble salts should also come through in the soda extracts. A further extraction method used on calcareous soils has been the Co_2 extraction method of McGeorge. Typical figures have been 20–30 p.p.m. P, which is well above his minimum requirement of *c.* 10. On such soils the Truog extract has given 300–500 p.p.m., and the NH_4F extract 70–180.

The value of these methods is being compared in connection with a series of maize trials, which form part of the Federal Research Programme.

4. MICRO-NUTRIENTS

During the year the Mervyn Harwell Square Wave Polarograph has been added to the micro-nutrient laboratory. As anticipated, previous experience of polarographic methods has enabled this instrument to be brought into service very quickly. It has proved very efficient, and naturally more sensitive and selective than the Cambridge Polarograph also in use. Methods have been investigated for the determination of copper and zinc in plant extracts. To the hydrochloric acid solution is added a potassium chloride base solution, the pH is adjusted to 2 (this was decided after a study of pH effect on the wave), and the solution is polarographed. Tests are now being made to include manganese determinations at the same time. The solochrome method for aluminium is used, but a greater sensitivity is obtainable than with the Cambridge machine.

Results obtained with the Mervyn instrument, as well as by the methods detailed in last year's report are presented in the respective sections for the crops with which these nutritional problems occurred.

Report of the Agricultural Chemist, Chitedze

Chemistry Section

SOIL ANALYSIS

1. FERTILIZER EXPERIMENTS (MAIZE)

Considerable data has now been accumulated from the more comprehensive type of district maize fertilizer trials which have been running throughout the territory for the last three seasons. The information obtained so far has enabled the following tentative conclusions to be drawn with regard to nitrogen and phosphate responses and recommendations.

Nitrogen

(a) *Sands and Loamy Sands*. This group contains up to .085 per cent. total nitrogen and all of them respond economically to dressings of at least 200 lb. sulphate of ammonia per acre and probably beyond. Addition of 100 lb. sulphate of ammonia per acre can be safely recommended on all analyses and 200 lb. on the majority.

(b) *Sandy Loams*. If the percentage total nitrogen is >0.10 the addition of N by the African farmer is only occasionally economic and not generally recommended. If below 0.10 per cent., addition of 100 lb. sulphate of ammonia per acre can be safely recommended and in some cases 200 lb. per acre. Exceptions to these rates are soils found on hot low-lying areas of the Lake-shore and Lower River, e.g., Baka, Lupembe (Karonga), Nyamphota (Chikwawa), especially if the pH is high.

(c) *Sandy Clay Loams*. Where percentage total nitrogen is >0.12 it would probably not be economic to apply N at present maize prices, though nearly always significant increases may be obtained from the addition of 100 lb. sulphate of ammonia per acre. Below 0.12 per cent., addition of 100 lb. sulphate of ammonia per acre can be safely recommended, and 200 lb. per acre if below 0.08 per cent., though it should be borne in mind that if funds are short two acres receiving 100 lb. sulphate of ammonia per acre will give a greater return than one acre receiving 200 lb. sulphate of ammonia per acre even at low levels of soil N.

(d) *Sandy Clays—Clays*. Apart from the Lake-shore conditions, etc., mentioned in (b) above, one could safely apply 100 lb. sulphate of ammonia per acre to all clays with under 0.13–0.14 per cent. N. and in some cases even larger amounts at lower N contents.

N.B.—The present economic response is 500 lb. grain per 100 lb. sulphate of ammonia.

TABLE I
Extraction of Phosphate from Soils of Varying Acidity

Soil No. sequence	Location	pH	Texture	Org. Carbon per cent.	NH ₄ F	NH ₄ F + HCl	HCl p.p.m.	Truog solution P.	Cold NaOH	Hot NaOH	Water	Soil No.
1	Chitakali	4.5	Sandy loam ..	4.0	57	194	137	11	171	274	9	1
2	Bandanga	4.9	Sandy clay loam to clay ..									
3	Chitakali	5.2	Sandy loam ..	1.2	70	110	40	14	189	299	10	2
4	Nchima	5.5	Sandy loam ..	4.2	114	211	97	5	215	284	7	3
5	Nchima	5.7	Sandy loam ..	1.0	9	40	31	19	27	69	9	4
6	Kasupe	5.8	Sandy loam ..	2.1	40	163	123	35	193	314	19	5
7	Namabalo	6.0	Loamy sand ..	1.0	101	224	123	11	185	294	20	6
8	Ncheu	6.0	Sandy loam ..	1.2	9	35	26	2	96	112	5	7
9	Chaone	6.2	Sandy clay loam	3.8	44	84	40	2	151	126	9	8
10	Makanga	6.3	Sandy loam ..	1.5	209	2,675	2,466	210	803	1,119	20	9
11	Lilangwe	6.4	" ..	2.6	180	933	753	189	763	816	31	10
12	Mfumba	6.5	" ..	2.2	70	1,144	1,074	32	105	143	22	11
13	Makanga	6.5	" ..	0.7	18	48	30	12	68	88	10	12
14	Mfumba	6.6	" ..	2.6	194	1,038	844	284	782	802	44	13
15	Kuntaja	6.7	" ..	2.1	66	79	13	11	54	122	19	14
16	Nyamphota	6.9	Sandy clay loam	1.6	22	44	22	5	94	112	6	15
17	Chapamuka	7.2	Sandy loam ..	1.0	150	607	457	225	198	189	86	16
18	Chiromo	7.8	Clay ..	1.3	57	511	454	157	88	54	48	17
19	Chiromo	9.0	Sandy clay loam	0.3	48	292	244	63	116	112	90	18
		9.4	" ..	0.2	40	182	142	136	93	27	112	19

Phosphate

Generally speaking the critical limit above which no significant response is obtained from the application of phosphate would appear to be between 50-60 p.p.m. phosphate determined as available phosphate by the ammonium fluoride (NH_4F) method. These are indications that this limit is somewhat higher in the more heavily textured soils due to increased fixation, but as yet these are not fully established.

Between 30-50 p.p.m. phosphate, soils fall into the borderline category, there frequently being marked responses to added superphosphate but often these do not quite reach significance. They are more likely to do so in sandy clay loams, rather than in sandy loams or loamy sands.

Below 30 p.p.m. phosphate, application of superphosphate at the rate of 200 lb. per acre is recommended for all soils, and almost always produces a significant response.

Unfortunately, from the point of economic return the application of such an amount of superphosphate is not warranted at the present time, although there is now a considerable amount of evidence to show that on a number of soils the stage is now being approached where the addition of superphosphate in small quantities at regular intervals would seem to be necessary to maintain existing supplies of soil phosphate above the critical level. The introduction of a 25: 10: 0 or similar mixture for use by the African grower in certain areas might well provide the answer to this problem, and it is hoped to carry out trials in the districts during the coming season, using such a mixture.

2. MISCELLANEOUS SOIL INVESTIGATIONS

Mbawa

(i) *Phosphate Status.* A preliminary examination was made during the 1957/58 growing season, of the soil from Block 4, on which the bulk of the maize fertilizer experiments were being grown. This arose from the fact that considerable variation was noted in the maize grown on adjacent plots which had received similar fertilizer treatments. As the season advanced these variations became more marked, and indicated two distinct zones of fertility running approximately from east to west across the block. This would invalidate results of experiments situated on the boundary of these zones. Furthermore bulk maize grown in both zones and receiving equal amounts of sulphate of ammonia showed excellent growth on the one hand and extremely stunted growth on the other. Phosphate deficiency was suspected to be the cause and subsequent examination of profile pits from both zones proved this conclusively.

Figures from typical pits in the two zones are given in Table II.

TABLE II
Available Phosphate Analysis

Zone of Adequate Phosphate			Zone of Low Phosphate		
Depth (in.)	Per cent. Nitrogen	Phosphate (p.p.m.)	Depth (in)	Per cent. Nitrogen	Phosphate (p.p.m.)
0-4½	.073	64	0-3½	.085	35
4½-10	.060	56	3½-9	.068	34
10-26	—	56	9-27	—	25
26-42	—	44	27-42	—	19
42-60	—	38	42-56	—	13

The results of this investigation clearly showed that a complete examination of the soil phosphate status, for all the major cultivated blocks at Mbawa, was necessary before the following season in order to assist in the choosing of sites for experimental work. Comprehensive samples were subsequently submitted and a detailed phosphate status map prepared.

(ii) *The Effect of Dung on Soil Fertility.* The value of dung on poor soils, as opposed to straight fertilizers, was clearly shown in analyses carried out on an experiment in progress at Mbawa. The soil in question had been under continuous maize cultivation for five years and plots within the experiment had received the same treatments over this period. Table III below, illustrates some of the more striking effects of some of these treatments on soil fertility.

TABLE III
The Effect of Dung on Soil Fertility

No.	Treatment	pH	Per cent. N	Avail. P. p.p.m.	K. me per cent.	T.E.B. me per cent.	B.E.C. me per cent.	Base Sat. per cent.
1	Dung (5 tons/acre)	7.10	0.113	228	1.47	8.8	6.8	fully sat.
2	Dung+N+P ..	7.15	0.142	272	1.59	10.4	8.0	fully sat.
3	N alone	5.50	0.094	122	0.48	3.3	3.8	87
4	P alone	5.95	0.083	138	0.49	3.8	4.8	79
5	N+P	5.80	0.090	131	0.39	3.9	4.3	91
6	Nil	5.75	0.083	109	0.42	3.4	4.5	76

me.% = milli-equivalents per cent. p.p.m. = parts per million.

The effect of the dung has not only been to raise the capacity of the soil to hold exchangeable bases (B.E.C.), but to raise the total of actual exchangeable bases present (T.E.B.). Its overall effect on the base saturation percentage is equally noticeable. Equally marked are effects on pH and the supplies of N, P and K which have been increased to a much greater extent when dung was added rather than straight fertilizers.

Analyses made on soils taken during a visit to the Misuku in April in connection with deficiency symptoms on coffee, provided evidence to support the theory that the Misuku was originally all covered by forest, but that present-day cultivation takes place on what used to be subsoil. This accounts for the acid nature of these soils and their low base saturation percentage. Deficiency symptoms that have been observed can probably be attributed to this. Analytical comparison of a forest subsoil with a present day cultivated topsoil is given in Table IV, from which it may be seen that texture, soil colour and base exchange capacities have considerable similarity.

TABLE IV
Comparison of Forest Subsoil and Present Day Cultivated Topsoil (Misuku)

Site	Depth (in.)	pH	Texture				per cent. N	Ads P. p.p.m.	Avail. bases me. per cent.			T.E.B.	B.E.C.	Base sat. per cent.
			C.S.	E.S.	S.	C.			K.	Ca.	Mg.			
Kasumbi Virgin-Forest	10-22	6.80	24 clay	18 loam	18 —	40 clay	.118	337 2.5 yr.	.63 5/8	9.5 red.	1.8	11.9	13.3	89
Katobo ..	0-6	5.20	11 clay	24 clay	22	42	.305	106 2.5 yr.	.14 4/6	2.0 red.	0.8	2.9	15.3	19

3. ROUTINE ANALYSIS AND ADVISORY WORK

The scope and numbers of samples dealt with under this heading (some 300) has increased enormously during the past year. Apart from soils received in connection with general fertilizer experiments both in the district and at research stations, this work has embraced such items as changes in nutrient status on the major rotation experiments, effects of grazing and pasture management on soil structure and nutrient status, selection of coffee nursery sites, fertilizer recommendations for tobacco estates, examination of groundnut "pop" soils and a certain amount of work for other Government departments.

NOTE.—Further work on Agricultural Chemistry will be found under the various crop sections.

Soil Physics Section

SEASONAL DISTRIBUTION OF SOIL MOISTURE AT CHITEDZE

Investigations have been in progress for three seasons on the soil moisture relationships and moisture requirements of the major cultivated crops, as compared with various types of fallow. Figure I summarizes rainfall and cropping histories of several of these treatments during this period, together with distribution of available soil moisture to a depth of 6 ft. This distribution is obtained by plotting the log resistance as given by the cylindrical gypsum moisture units which were installed under the various treatments when the investigations first commenced. They provide information concerning the uptake of water from the soil by plants, over the available moisture range, and indicate when wilting point has been reached.

The following information is provided by Fig I.

(1) BARE FALLOW

In this treatment the land was kept clean weeded throughout the growing seasons and therefore was able to store considerable quantities of available water. Normally, wilting point is only reached in the top foot of the profile as a result of surface drying effects, but in the prolonged 1957 dry season it has also reached the second foot.

(2) VOLUNTEER COVER—MAIZE

The effective removal of all available water by the profuse rooting systems of indigenous grasses and herbs is clearly shown. In both the 1956 and 1957 seasons wilting point was reached at the 4 ft. level and the 5th and 6th ft. levels were also being tapped. A considerable quantity of this moisture is removed by further transpiration losses due to continued growth of certain grasses during the dry season. Fortunately at Chitedze the amount of rainfall and its distribution are normally sufficient to overcome these losses of soil moisture fairly quickly, so that a subsequent crop, in this case maize, can be produced without any deleterious effects on growth or yield.

(3) TOBACCO—MAIZE

It will be observed that tobacco draws most of its moisture supplies from the top foot of the profile and its demands are considerably less than those of maize. The effects on available moisture of the rather longer dry season in 1957 are again shown. The greater usage of available water shown by maize grown after tobacco in the 1958 season when compared with that grown after volunteer cover or maize is also of considerable interest. This is thought to be due primarily to residual fertilizer effects, clean weeding and the presence of well-made ridges in the tobacco plot. Growth was more vigorous throughout the season and yields were higher.

Fig. 1— Soil Moisture Distribution Under Crops
And Fallow Treatments — Chitedze

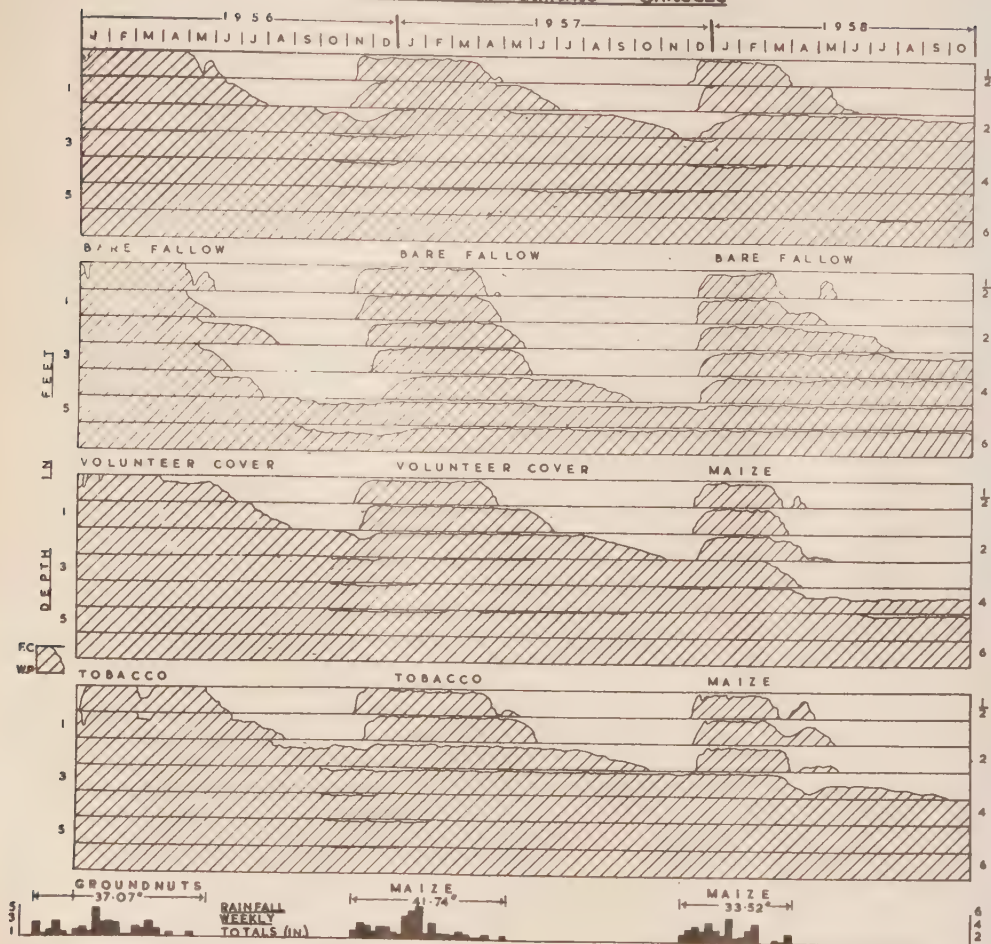
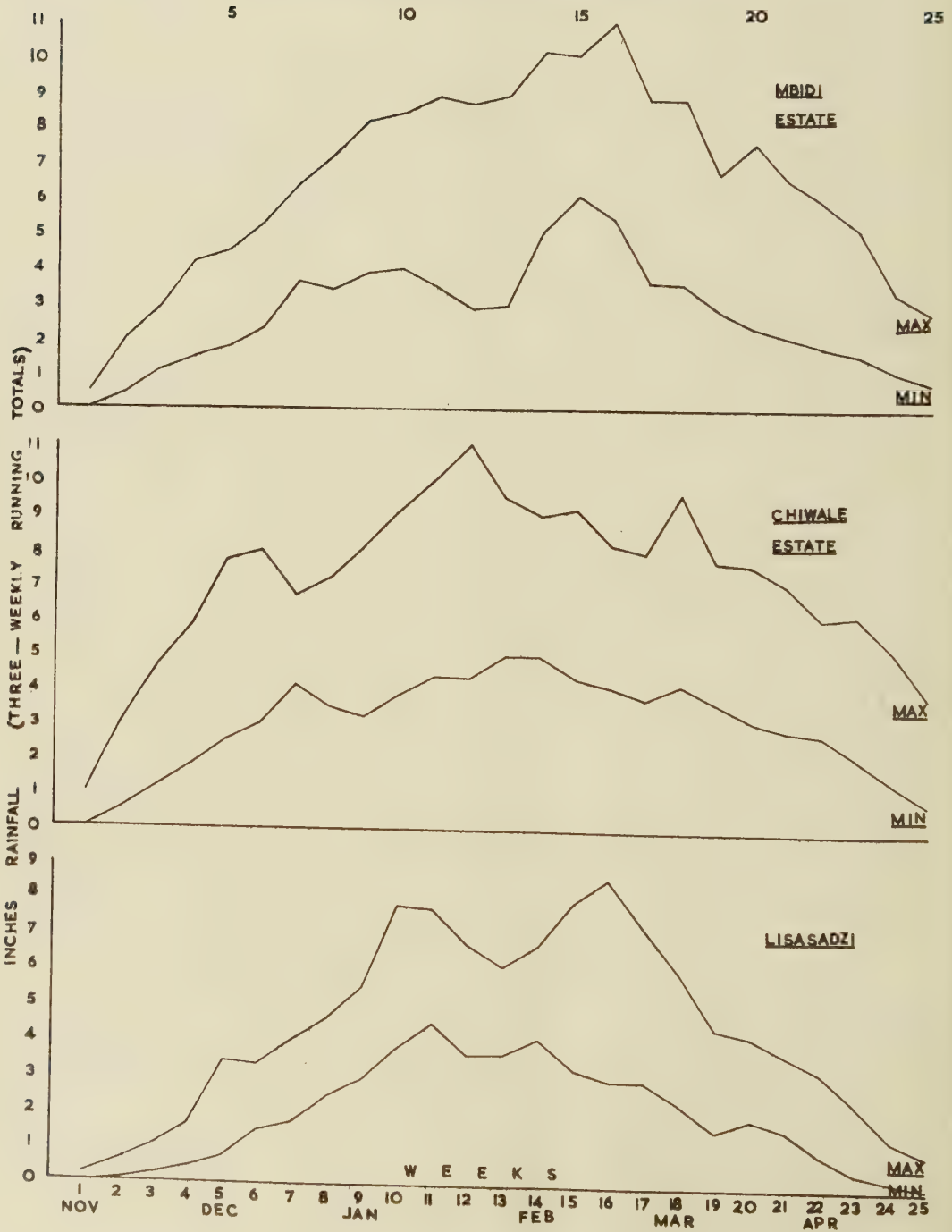


Fig. II — Rainfall Confidence Graphs



(4) GROUNDNUTS—MAIZE

The demands for available water are least in the case of groundnuts and where rainfall is adequate as at Chitedze the effects are barely noticeable. Although the plant roots to depths of 5 or 6 ft. the volume of these is comparatively small when compared with maize or tobacco.

RAINFALL CONFIDENCE GRAPHS (1 : 1 Confidence Limits)

During the past year a considerable number of these graphs have been prepared according to the method of H. L. Manning, Namulonge, Uganda. They provide the farmer and research stations with more accurate information regarding the maximum and minimum limits within which rainfall may be expected during any week of the period covering the wet season, i.e., November to April.

In nearly all cases daily rainfall records for a period of at least ten years and usually more have been used in the preparation of the graphs, a selection of which is given in Fig. II.

USE OF THE GRAPHS

The horizontal axis represents the rainy season from November to April and consists of 25 standard weeks which correspond to the periods given in Table V. The vertical axis represents inches rainfall plotted from transformed three weekly running totals. Each total is the combined totals of the previous week, the particular week under consideration and that of the week following. This is necessary when considering the variable moisture requirements of crops.

At Mbidi Estate for example in the fifth standard week, 22nd–28th November, a minimum of 1.7 inches and a maximum of 4.5 inches of rain would be expected during the three week period 15th November–5th December, in three years out of four.

TABLE V
Days of the Month against the Standard Week

<i>Period</i>			<i>Week</i>	<i>Period</i>			<i>Week</i>
Oct.	25–31 ..	..	1	..	Jan. 24–30 ..	14	
Nov.	1–7 ..	..	2	..	Feb. 31–6 ..	15	
	8–14 ..	..	3	..	7–13 ..	16	
	15–21 ..	..	4	..	14–20 ..	17	
	22–28 ..	..	5	..	21–27 ..	18	
Dec.	29–5 ..	..	6	..	Mar. 28–6 ..	19	
	6–12 ..	..	7	..	7–13 ..	20	
	13–19 ..	..	8	..	14–20 ..	21	
	20–26 ..	..	9	..	21–27 ..	22	
Jan.	27–2 ..	..	10	..	Apr. 28–3 ..	23	
	3–9 ..	..	11	..	4–10 ..	24	
	10–16 ..	..	12	..	11–17 ..	25	
	17–23 ..	..	13	..	— ..	—	

ECOLOGY

Mpingu-Ngongonda-Kandiani

A land use-soil survey was made of an area of twelve square miles in Lilongwe District, comprising part of the catchments of the Mbabzi and Lingadzi systems. The main Lilongwe-Fort Manning road bounds the scheme on the south, the Salima short cut road on the south-east and the Nsaru road runs approximately east and west through the middle of the area.

CLIMATE

Average rainfall 37.64 inches, with a variation of 30.29 to 46.12 in a period of eight years. The rain falls mainly from November to March with a peak of 11.00 inches in January.

SOILS AND VEGETATION

There are two clearly defined catenas in the area, in the Ngongonda section and Mbewe section respectively. Both have a characteristic colour change from red to grey through yellow red and yellow brown, from watershed to swamp centre.

1. NGONGONDA CATENA

From watershed to swamp or stream course centre the series are as follows:

Ngongonda-Kandiani-Mwanjema-Manzi-Mbabzi, the series names being derived from major villages in the area. On the south side of the Mbabzi "dambo" is found an additional soil type, the Chipinika series.

(1) *Ngongonda series*—Dark red sandy clays

0-12" 2.5YR 3/2 Dusky red to 5YR 3/2 Dk. reddish brown sandy clays to sandy clay loams

12-25" 2.5YR 3/3—5YR 3/4 Dark reddish brown sandy clay

25-60" 2.5YR 3/6 Dark red sandy clay.

Structure massive, without well defined horizons; drainage good, no mottling at 60 inches; roots penetrate to the bottom of the sampled pits.

Grits of the order of 1 per cent. to 4 per cent., occasional sites with some murram nodules.

Site characteristically flat at the highest levels between drainage lines.

Nitrogen fair to medium, phosphate borderline.

Potash low to very low (on the sampled profiles).

These soils carry a characteristic mixed vegetation which can be defined as *Piliostigma-Acacia-Combretum* woodland with tall grass cover. The listing includes the following species in the tree canopy:

Piliostigma thonningii

Combretum gueinzii

Pterocarpus rotundifolius

Acacia campylacantha

Combretum ghasalense

Pterocarpus rotundifolius can be taken as an indicator of definitely good soils in the area.

Less conspicuous species:

<i>Erythrina tomentosa</i>	<i>Parinari mobola</i>
<i>Strychnos spinosa</i>	<i>Terminalia sericea</i>
<i>Lonchocarpus capassa</i>	

The herbaceous layer is also very rich and often tall and reedy. It includes:

<i>Hyparrhenia variabilis</i>	<i>Hyparrhenia rufa</i>
<i>Digitaria setivalva</i>	<i>Setaria sphacelata</i>
<i>Andropogon amplexans</i>	<i>Brachiaria brizantha</i>

These soils are widely cultivated. *Rottboellia exaltata* (Nsonthe), is a very widespread weed and its vigour is a ready guide to the "heart" of the land.

(2) *Kandiani series*—Yellow red sandy clays

Dark brown to dark reddish brown in the surface.

0-6"	7.5YR	4/2	Dark brown sandy clay loam
6-12"	7.5YR	4/4	Dark brown sandy clay
12-45"	5YR	4/6	Yellow red sandy clay
45-60"	5YR	5/8	Yellow red sandy clay.

Structure massive, texture of moist sub-soil floury, no clear profile differentiation, no mottling at 60 inches; drainage good. On gentle slopes to swamp margins, often flat, especially at border of Ngongonda series. Nitrogen fair to medium, phosphate borderline, potash low.

The actual borderline between the above soil series is difficult to define without a grid soil survey. It is also vague owing to a gradual change in colour from 2.5YR to 5YR range of colour.

The Kandiani series are in some cases associated with murram or cuirass laterite, especially where they border on the Mwanjema series described below.

The vegetation of the better phases of the Kandiani series is woodland very similar to that described for the Ngongonda red sandy clays. On the poorer phases *Pseudoberlinia paniculata* assumes greater conspicuence and even dominance. Where this is the case, the soils although arable should be regarded as differing from the Ngongonda red sandy clays, from an agricultural point of view.

(3) *Mwanjema series*—Dark brown sandy clay loams

Marginal to the swamp and seasonal swamp soils, often associated with the outcrop of cuirass laterite and lateritic murram. On the slope between the Kandiani series and the seasonal and perennial swamps or water courses.

0-12"	10YR	2/2	Very dark brown sandy clay loam
12-24"	10YR	3/2	Very dark grey brown sandy clay loam
24-36"	10YR	3/4	Dark yellowish brown sandy clay loam
36-45"	7.5YR	4/4	Dark brown sandy clay loam mottle often apparent, black, yellow brown and red brown with murram;
or			
0-6"	7.5YR	4/2	Dark brown sandy clay loam
6-20"	7.5YR	4/4	Dark brown sandy clay loam
20-43"	7.5YR	5/4	Brown sandy clay loam
43-45"	7.5YR	5/4	Brown sandy clay loam with murram.

Good crumb structure when moist, drainage fair in the soil above laterite; with increase in murram there is more obvious moisture. Roots penetrate to laterite and into murram.

Nitrogen fair to medium, phosphate borderline, potash low.

There is a wide variation in the vegetation of this soil type.

(a) *Acacia campylacantha* tall woodland with tall grasses. In several places along the Mbabzi "dambo" *Acacia campylacantha* assumes dominance. The mature trees are tall and well grown and there is a good cover of palatable grazing grasses within this woodland type, often characterized by *Panicum maximum*. The occurrence of cuirass laterite does not appear to affect the growth of *Acacia campylacantha*.

(b) *Acacia campylacantha* woodland, when cut over, grazed and cultivated gives rise to a scrubby woodland of *Acacia* with *Philiostigma thonningii*, *Dichrostachys nyassana*, *Markhamia acuminata*, *Flueggia virosa* and *Cassia petersiana*. This may be further degraded to:

(c) *Royena sericea* with an overgrazed sward of *Sporobolus pyramidalis*, *Hyparrhenia filipendula* and *Urochloa pullulans*. Typical of grazing lands near the village areas.

(4) *Manzi series*—Grey sands impregnated with clay, mottled at depth.

0– 4" Loamy sand, very dark grey

4–12" Dark grey loamy sand impregnated with clay, water seeps into the pit between 4–12"

12–18" Slightly mottled coarse sandy loam

18–24" Grey and yellow brown mottled sandy loam, clay impregnated

24–36" Blue grey sandy clay with 5YR 4/8 yellow red and 10YR 4/8 yellow brown prominent mottle.

Waterlogged but with apparent water movement through the soil. Structure nil. Sand impregnated with clay, clay increasing with depth, clay holding the sand together.

The Manzi series carry a variety of vegetation types and the definition of the soil type as a single series probably errs in classing more than one series together. On the map they are divided into two categories according to their water relationships. However, the soils agree in being sands impregnated with clay with mottle at depth. They are on the whole poor.

(a) *Brachystegia stipulata* is characteristic of the drier, sandier phases of the Manzi series and may be found at the heads and along the margins of the seasonal swamps. Often associated with it are *Burkea africana* and *Parinari mobola* scrub.

The grasses are mainly of the group *Arundinellae* and include *Tristachya hispida*, *T. rehmannii* var. *helenae*, *Loudetia superba* and *L. simplex*, also *Digitaria diagonalis* and *Heteropogon contortus*.

(b) *Pseudoberlinia paniculata* and *Diplorrhynchus* sp. are also to be found on the Manzi series with a similar herb layer.

(c) *Acacia campylacantha* is often found as a tall tree on soils of the Manzi series and into the sandy seasonal swamps. This is particularly the case of the swamp which lies to the south of the Nsaru road and spills into the Mbabzi near Mbabzi estate boundary. Also the swamp which drains north from Mwalimbwe Village.

The wetter phases are generally grassland, often with a few scattered shrubs or trees. *Acacia* invasion is most probably limited by fires.

(d) The grasslands include the following species:

Setaria sphacelata, *Hyparrhenia filipendula* and *Panicum graniflorum*, on the better phases; *Tristachya hispida*, *T. rehmannii*, *L. superba*, *L. simplex*, *Digitaria brazzae*, *Brachiaria humidicola*, *Eragrostis* spp. on the sandier phases; *Eragrostis chapelierii*, *Sporobolus festivus*, are characteristic of the overgrazed areas; other species comprise a very long list which includes *Elyonurus trapnellii* on the sandier soils; *Eulalia geniculata*, *Capillipedium parviflorum*, *Themeda triandra*, *Hyparrhenia rufa* and *H. nyassae*, on the better soils.

On the wetter phases *Leersia hexandra* and *Echinochloa pyramidalis* are conspicuous.

(e) The grasslands change under grazing and become dominated first by *Urochloa pullulans* and later by *Sporobolus pyramidalis*. If the succession can be halted when *Urochloa* becomes dominant a very desirable sward results but overgrazing leads to *Sporobolus* assuming dominance and this grass is both tufted and unpalatable and hence undesirable from both conservation and grazing points of view.

(f) There are other communities on the Manzi series which include *Terminalia sericea* as trees, *Lonchocarpus capassa* as both trees and as scrub, *Markhamia acuminata* as scrub, *Royena sericea* as scrub.

(5) Mbabzi series—Black silty to sandy clays

Soils very wet to permanently wet at the centres of the swamps and their lower levels and in water courses. The water courses are often choked with vegetation through which the water flows quite swiftly. Disturbance by puddling, trampling and overgrazing leads to erosion of such water courses.

Aeschynomene schimperi, *Echinochloa pyramidalis* and numerous sedges are characteristic vegetation.

The above soil series and vegetation characterize the catena found over most of the Ngongonda area. The redder soils at the water shed, grading through yellow red to yellow brown, to brown to grey to black at the water course centre. There is a decrease in the clay fractions from water shed to swamp margin. Sand soils of the swamps and seasonal swamps become clay impregnated with depth and distance from source.

(6) Chipinika series—Deep loamy sands with murram at depth.

At the head of the seasonal swamps on the south side of the Mbabzi stream are areas of deep sand accumulation which probably represent the first stage of deposition of material picked up by sheet erosion of the higher lying areas.

0-12"	10 YR	3/1	Very dark grey loamy sand
12-36"	10 YR	6/2	Light brownish grey loamy sand
36-52"			Loamy sand with 30 per cent. nodules
52-62"			Strong brown mottle apparent, 30 per cent. nodules
63" +			Grey brown loamy sand impregnated with clay, up to 40 per cent. nodules and concretions, wet.

Drainage appears to be reasonable in upper horizons. Mottling and concretions define the horizons. Roots penetrate to depth, nutrients are low.

The vegetation is very characteristic. *Ricinodendron rautanenii* is the dominant tree. It reaches over 50 ft. in height and is often over 6 ft. in girth at the base. Associated woodland trees are well grown and tall and include *Pterocarpus angolensis*, *Burkea africana*, *Combretum ghasalense*, *Albizia versicolor*, *Strychnos* sp., *Psorospermum febrifugum*, *Grewia* sp. and *Terminalia sericea*. The grasses are often tall and reedy despite the sandy soils and there are numerous leguminous shrubs and wild yams.

One vegetation community not included in the above notes is that of *Acacia galpinii* (not to be confused with *A. nigrescens*). There are several groves of this fine tall *Acacia* at intervals along the swamp margins.

The second distinct catenary sequence is found in the northern sector of the area, between the Cirikanda road and the Lingadzi River.

2. MBEWE CATENA

(7) *Mbewe series*—Red clay with lateritic nodules or broken cuirass and cracked quartz at depth.

0- 6"	7.5 YR	4/4	Dark brown sandy clay loam
6-12"	5 YR	4/6	Yellowish red clay
12-34"	2.5 YR	4/6	Red clay
34-42"			Sandy clay with 45 per cent. quartz gravel and concretions, latter black when broken.. Many rounded quartz pebbles 2"×4"×1" to 2"×1.5"×1.5".
42-56"			Sandy clay loam with fewer nodules and more finely cracked quartz to 35 per cent.

This soil series occupies a small area near Mbewe Village and is characterized by a cover of *Uapaca kirkiana* together with *Pseudoberlinia paniculata*, *Uapaca nitida* and *Diplorrhynchus* sp.

(8) *Mumba series*—Yellow red sandy clays.

0- 6"	10 YR	3/2	Very dark grey brown sandy clay loam
6-12"	7.5YR	4/4	Dark brown sandy clay
12-36"	5YR	5/8	Yellow red sandy clay
36-48"	5YR	5/8	Yellow red with indistinct yellow mottle
48-52"	5YR	5/8	Mottle clearer, soft earthy concretions
52-60"			Red brown—yellow brown mottle apparent, soft nodules, brown or blackish when broken.
			Drainage in upper layers good.

These soils are the most extensive in the Northern sector and although morphologically they closely resemble the Kandiani series, the crops being grown on them are distinctly poorer than those on the Kandiani series. The vegetation indicates the difference quite clearly. *Pseudoberlinia paniculata* is the dominant tree with *Brachystegia spiciformis*, *B. longifolia*, *Diplorrhynchus* sp. and *Parinari mobola*. In the herb layer *Digitaria diagonalis* is common, with *Themeda triandra*, *Panicum phragmitoides*, *Eriosema affine* and *Adenodolichos punctatus*. The vegetation readily forms scrub after cultivation.

(9) *Mariko series*—Brown sandy clay loam.

0-12"	7.5 YR	3/1	Very dark grey loam sand
12-16"	7.5 YR	3/2	Dark brown sandy loam
16-22"	7.5 YR	4/4	Dark brown coarse sandy clay loam
22-45"	7.5 YR	5/6	Strong brown coarse sandy clay loam.

Drainage appears to be satisfactory but the soil is distinctly damp at depth. Clay increases with depth. Vegetation similar to that of the Mumba series.

(10) *Grey Sands* with mottle at depth, closely resembling the Manzi series.

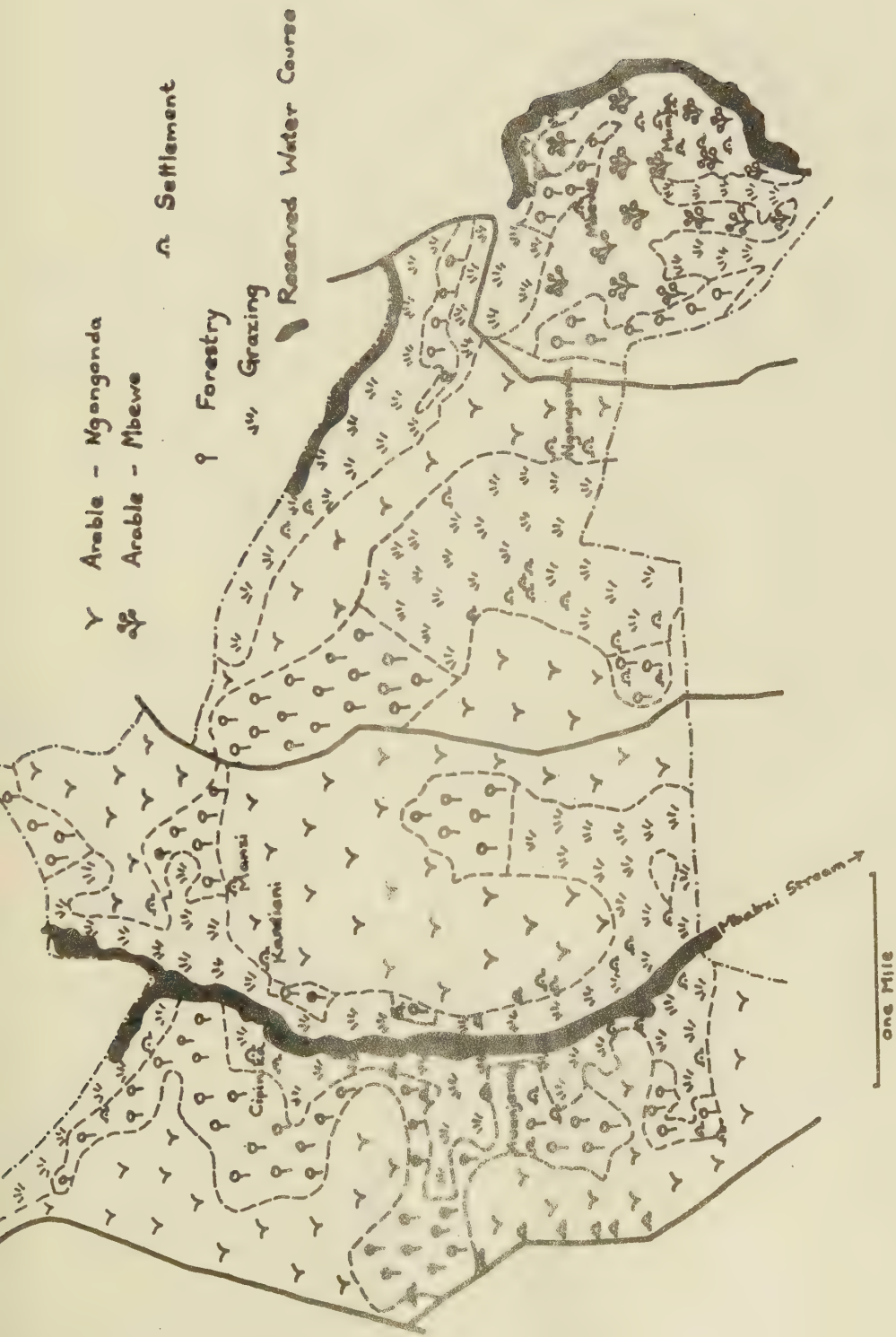
Vegetation varies from scrubby *Pseudoberlinia paniculata* to derived grassland of low cover often characterized by *Loudetia superba*, *Tristachya* spp. and *Bewsia biflora*.

(11) Wetter phase of the above at swamp centres.

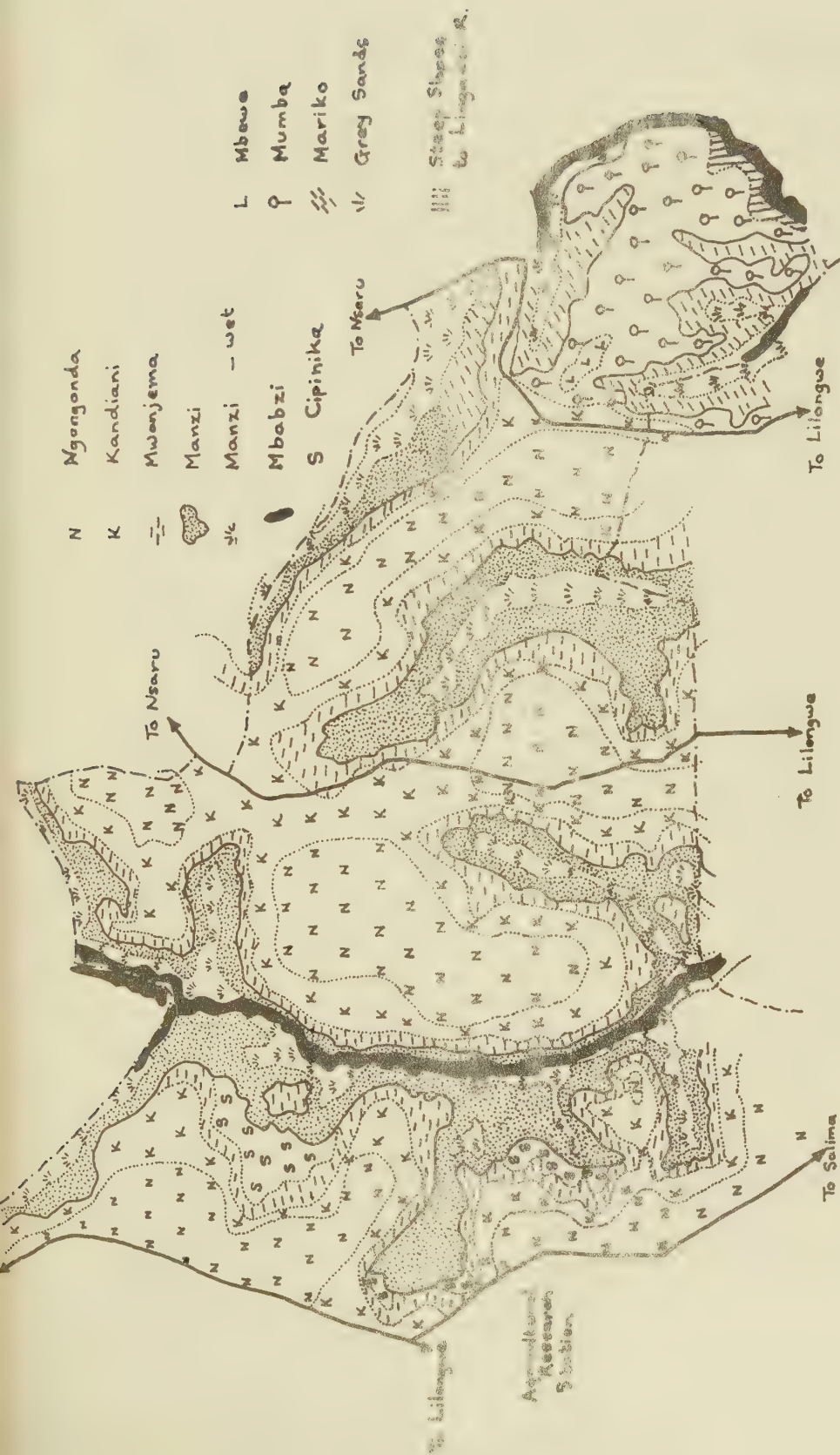
(12) In addition to the Mbewe catena are the colluvial slopes to the Lingadzi River and a small belt of alluvial soil along its banks.

LAND USE

(1) *Ngongonda series*—A good arable soil, capable of growing the crop complex of Lilongwe area. Suited to high class dark-fired tobacco growing, with maize and groundnuts in the rotation. Highly receptive of water, not waterlogged, good permeability.



LAND USE
MPINGU-NGONGONDA
— KANDIANI —



(2) *Kandiani series*—this series is divisible into three categories:

(a) *Good arable soil*, especially where adjacent to the Ngongonda series. In this location the soils of the two series can be treated in the same manner in the preliminary stages of planning.

(b) Towards the borders of the Mwanjema series there is a falling-off in crops that is most marked in the tobacco. Western tobacco in this location resembles Burley in appearance, as the leaves are thin and do not fall over. This must be borne in mind when recommending fertilizers for cropping systems.

(c) Under certain circumstances the laterite cuirass break is in the soils of the Kandiani series and these soils must be avoided for annual crops. The effect of the laterite cuirass is clearly demonstrated in the Kakungu Village Land Improvement Scheme where there are very marked differences in the maize crop.

(3) *Mwanjema series*—Two categories are readily recognizable:

(a) Soils with laterite cuirass which should be avoided for arable crops.

(b) Soils below the laterite cuirass break which are quite capable of carrying crops as good as and better than the lower slopes of the Kandiani series.

On the land use map these soils have been generally classed as pasture or forest land. This is not because they are incapable of producing crops but because of position in the catena and the location of the laterite break. This observation also applies to the Kandiani series.

The laterite break is land that is not of great value for either pasture or arable, but *Acacia campylacantha* and other trees appear to be able to grow and flourish despite the cuirass and murram. Areas where it occurs are best put under forest or utilized as road and village sites.

This is so in the case of many Achewa villages. Kandiani itself is located very close to the laterite, Kapenula is completely on laterite cuirass. Paths connecting the villages often run along the cuirass which outcrops in many places.

In planning any part of the scheme this laterite break must be taken into account.

(4) *Manzi series*—These soils are not arable soils although attempts are made by local inhabitants to cultivate them. Where they border the Mbabzi series there are sites for tobacco nurseries and dry season “dimba” gardens.

On the land use map they are designated as forestry and grazing areas and no account is taken of “madimba” and nurseries.

In considering the allocation of forest and grazing areas several points are taken into account.

GRAZING

The grazing problem is closely linked with the provision of winter and summer grazing assuming that no fodder is conserved. The swamp areas should provide winter fodder by virtue of their prolonged wetness but at present they are being used the whole year round under no system of management.

In the land use plan, the Manzi series grazing areas are those areas which are wet for long periods of the year, but as a supplement the Mwanjema series of the valley sides are included as grazing. This is to allow for strip grazing parallel to the swamp centre line as swamp grazing management should aim at keeping the grass as young as possible, consistent with the prevention of puddling as the soils become waterlogged.

Provision of grazing supplementary to natural pastures raises the problem of planted leys.

FORESTRY

Tall natural *Acacia campylacantha* has been observed on the Manzi and Mwanjema series, and following this observation soils of these series have been set aside for forestry. In many cases the seasonally wet phases which have prolonged water-logging have been avoided.

Land which has laterite cuirass and murram near the surface has also been set aside for forestry, again following observations on the natural vegetation. These sites are of no use either for arable or grassland agriculture. They result in tremendous variation in growth on a holding where crops are concerned and grasses soon dry off in such areas with the onset of the dry season.

BUSH ENCROACHMENT

A problem associated with the Manzi series and grazing is present and subsequent bush encroachment. Several species are involved but *Royena sericea* is perhaps the most persistent.

Where the scrub contains *Piliostigma thonningii* as a constituent it will be worth while preserving certain individuals as browse plants. *Piliostigma* contributes valuable leaf and pod browse during the winter.

(5) *Mbabzi series*—The water-courses are mainly reserved. The soils of the Mbabzi series will have to carry the tobacco nurseries and "dimba" gardens and the utilization of these areas is a specialized problem in soil conservation.

Watering places for villages and for cattle will also have to be provided on or at the border of this series. Where cattle are involved under present management puddling leads to erosion of the silty clays.

(6) *Cipinika series*—Deep sands set aside entirely for forestry.

(7) *Mbewe series*—Shallow soil with lateritic murram and quartz horizons set aside for forestry.

(8) *Mumba series*—Under the Mbewe catena heading this is the only soil type suited to arable cropping and this must be of a specialized type. Legumes are required to build up the nitrogen status and fertilizers will be required if good crops are to be expected. The soils are best suited to groundnut cultivation.

Tobacco grown on these soils was very poor in appearance.

(9) *Mariko series*—These soils will give pasturage or provide forest land according to requirements.

(10) *Grey sands* in the Mbewe catena will provide poor pasturage and are perhaps much better suited to forest projects.

(11) *The colluvial slopes* and alluvial flats of the Lingadzi River are of relatively small importance being of small area. They are however cultivated and should be adequately conserved.

Reconnaissance Survey—The soils map produced for the scheme represents a reconnaissance survey and the boundaries of soil types are arrived at by extrapolation from sampled points using aerial photographs and geomorphological features as guides.

Land Use Boundaries—Give and take between the boundaries on the map can be put into practice on the ground.

The Ngongonda series are essentially arable lands but certain phases of the Kandiani series can be treated as either grazing or arable according to necessity. Where crops are seen not to flourish to the same degree as elsewhere, and land is

available, the grazing land boundary (or forest boundary) can be extended at the expense of the arable land. This may well be the case near Kango Village. In the case of the Mwanjema series, a good deal of cultivation is at present taking place on these soils and some of it on land that is yielding good crops. The reason for including such series in the grazing or forest land is that they usually fall below the cuirass break and it is convenient to put them into the grazing system to provide for wet season pasturage.

If one takes into account the fact that a considerable acreage of the Ngongonda and Kandiani series is under scrub, because of livestock in and around villages, it is more than likely that an exchange can be effected if control of livestock is tackled at an early stage in the planning. The main trouble is goats in cultivations near the villages. There must also be provision in these areas for thatching grass.

The boundaries between forest and grazing are very much more give and take than those between arable and other activities.

Lands that should be avoided for grazing are the more sandy phases of any series as the grasslands on these soils will tend to be poor with *Arundinellae* dominating the sward.

Lands to be avoided for forestry are the wetter phases of the seasonal swamp soils.

Economic and Social Considerations

Health—The Kandiani area is full of malaria at a critical time of the year. This and conjunctivitis were contributing at the time of the survey to many seriously weedy gardens.

Pise-de-terre house and barn building is a contributing factor in that the pits are malaria mosquito breeding grounds.

Conjunctivitis is probably a result of insanitary living conditions and dirty villages.

Population Increase—A careful estimate of land for future increase must be made now before division and fragmentation of holdings takes place. How the situation can be managed is a great problem but education must play a part.

A rise in yields by better cropping systems only alleviates the situation for a short while. Farming must pay, especially for the bigger farmer, and there must be attractive prospects elsewhere for the "younger-end" of the families. Higher education provides prospects away from the land.

Bwanje Valley

A reconnaissance survey of present land use in the Bwanje Valley was carried out from Penga-penga to Kasinje and arising from this a more detailed survey was made of the land use on the colluvial slopes below the escarpment.

The following categories of land are distinguishable in the area.

(1) Alluvial fans and flats—densely cultivated characterized by *Faidherbia albida*.

(2) Colluvial slopes at the foot of a well-defined escarpment. In places with dense cultivation (including A. Dent's estate) but otherwise sparsely used. Characterized by *Sclerocarya birrea*, *Ostrya derris stuhlmannii*, *Terminalia sericea* and *Pterocarpus angolensis*.

(3) Belts of *Acacia campylacantha* ("tributary" to the Bwanje) on black cracking clay. Wet and waterlogged in the wet season.

- (4) Belts and areas of *Acacia seyal* on black clays, waterlogged in the rains.
- (5) Belts and scattered *Colophospermum mopane* woodland. Intractable soils.
- (6) Areas of cultivable land between the alluviums and sections 3, 4 and 5 with vegetation as on the colluvials, with *Adansonia digitata*, *Cordyla africana* and in places *Acacia campylacantha*.
- (7) Hill foot, red brown gritty clays, often shallow, often actively eroding but with scattered tobacco gardens belonging to villagers who cultivate the alluviums. Found between the *Brachystegia* of the Ciripa plateau and the Bwanje on the east bank.

The area surveyed in greater detail was that part of the Bwanje Valley north of Penga-penga to Dent's estate turn off; and west of the railway line to the hill and escarpment foot.

TOPOGRAPHY AND RELIEF

A sharp, low escarpment runs approximately NW.-SE. on the west of the railway line with occasional wide entrants into the hills. At the foot of the escarpment there is a sloping hill foot colluvium often with many gullies and rolling topography near the hill foot. In places there are depressions and pans.

SOILS AND VEGETATION

On the whole the soils are hill foot colluvia although in some cases there is almost a clear stratification indicating alluvia. There is variation in texture and colour and apart from those soils found in depressions, boundaries are indefinite. The range is from dark brown sandy loam to dark brown sandy clay loam with clay loams in the depressions. There is a marked tendency for the soils to be generally lighter south of the Matundu River.

- (1) Typical of the area near Sharpevale is profile 2/23/758 near Nkwani Village.

0- 6" Very dark grey brown (10 YR 3/2) sandy loam
 6-12" Very dark grey brown sandy clay loam
 12-22" Dark brown (7.5 YR 4/2) sandy clay loam
 22-40" Brown (7.5 YR 4/4) sandy clay loam.

There is an increase in the gravel fraction with depth. The nutrient status is high and pH alkaline to neutral.

The vegetation is a mixed, tall, woodland with tall grass characterized by the presence of *Sclerocarya birrea* and *Ostryoderris stuhlmannii* together with *Combretum ghasalense*, *Lonchocarpus capassa*, *Adansonia digitata*, *Acacia campylacantha*, *Albizzia harveyi*, *Popowia obovata* and in the herbaceous layer *Hyparrhenia* spp.

- (2) In depressions and slight valleys the soils become heavier in texture and darker in colour with higher potassium, calcium and magnesium. The soils are heavy and intractable and generally avoided by the indigenous cultivators. These soils lie wet in the rainy season.

1/17/758 near Chingamba Village.

Taken in a depression.

0- 4" Dark grey (10 YR 4/1) clay
 4-12" Very dark grey brown (10 YR 3/2) clay
 12-24" Very dark brown (10 YR 2/2) clay.

Acacia campylacantha is the dominant tree of the depression with *Combretum ghasalense*, *Commiphora* sp. and *Lonchocarpus capassa*. In the herbaceous layer *Setaria phragmitoides* is often dominant with numerous *Acanthaceae*.

(3) Towards Penga-penga the lighter soils occur, for example 1/24/758 near Sanjani Village.

- 0- 4" Very dark grey (10 YR 3/1) sandy loam
- 4-12" Very dark grey brown (10 YR 3/2) sandy loam
- 12-36" Dark grey brown (10 YR 4/2) sandy loam
- 36-42" Brown (10 YR 5/3) loamy sand.

The nutrient status is good even in such a sandy profile.

The vegetation is a medium woodland with *Terminalia sericea*, *Pseudolachnostylis maprouneifolia*, *Burkea africana*, *Diospyros kirkii*, *Pterocarpus angolensis*, *Bauhinia petersiana*.

As one approaches the hill foot *Pseudoberlinia globiflora* becomes frequent to dominant, with *Diplorrhynchus* sp.

In the herb layer are *Themeda triandra* var. *hispida*, *Hyparrhenia filipendula* and *Andropogon amplexans*.

Further to the above vegetation-soil groupings there are the following communities:

(4) *Faidherbia albida* is common north of Sharpevale on soils which resemble alluvials. They are densely occupied.

(5) *Terminalia sericea* assumes dominance on soils of free draining or sandy nature and is often associated with *Albizia versicolor* along main drainage lines.

(6) *Khaya nyassica* is found along the main stream systems with *Pennisetum purpureum* in dense pure stand in the actual river bottom.

(7) On the gullied and broken country there is the formation of thicket and standards. The standard trees include *Adansonia digitata*, *Sclerocarya birrea* and *Acacia nigrescens* with *Popowia obovata* common among the thicket species. Such thicket species are found along the gullies as far as the road.

(8) *Oxytenanthera abyssinica* is found in pure stand in several places and should be a valuable asset to this part of the valley. It is usually associated with drainage lines.

(9) Thickets are found at the foot of the hills where the streams debouch from the escarpment. Prominent among the characteristic species are *Diospyros* sp. and *Grewia* sp. with *Acanthaceous* shrubs.

(10) Of less importance but of interest:

(a) *Brachystegia boehmii*, *B. tamarindoides*, *Diplorrhynchus* sp., *Pseudoberlinia globiflora*.

(b) *Sterculia quinquiloba*, *Bauhinia petersiana*, *Diplorrhynchus* sp.

(c) *Diospyros kirkii*, *Diplorrhynchus* sp., *Pseudolachnostylis maprouneifolia*.

On rocky foothills and hills to the west.

WATER SUPPLIES AND DRAINAGE

Most of the rivers in the area are sand rivers, none of which had surface water in them where they crossed the road. Several had water in their upper reaches near the hill foot.

Many streams issue from the hills and have deep rocky gorges with pools and waterfalls but most of them were dry. A few still had running water and were being used by the villagers. It was reported that some of these streams only flow for part of the day, but this was not observed.

At Nkwani village a spring supplies the water.

In the area are several wells and boreholes but on the whole the water supplies are poor.

PRESENT AGRICULTURE

Maize and air-cured tobacco are the main crops. Numerous legumes are planted and do well, including pigeon pea, cow pea, lima beans, velvet beans, bambarra ground bean and dolichos. Groundnuts are grown but there is frequent occurrence of "pops".

Bananas are grown in groves along the broader river valleys.

Tomatoes are found everywhere in gardens and as volunteers.

PESTS

Baboons and monkeys are very numerous especially near the hills, and pigs are said to be common.

LAND USE

The limiting factors in land use in the area under consideration are connected with drainage and erosion. From observation it appears that many of the gullies are of old standing and that the natural vegetation has to some degree stabilized them. The heads of these gullies are cutting back in places and this feature is to be taken into account when planning the area. Demarcation of the gullies and preservation of natural vegetation will contribute to their stabilization.

The fertility of the soils is bound up with the nature of the clay fraction and conservation should be aimed at preserving the clay fraction.

The Bwanje soils are said to show a tendency to waterlog in the rains although this feature is not apparent from profiles, other than those in depressions.

With certain phases of the sandy loam with grits the "bad land" or gully and sharp slope topography is very marked and this is so in the Bwanje Valley near the hill foot. Such terrain is not of potential value for resettlement and planning. The country can be spotted from the air photographs but is to some degree masked by the vegetation of thicket and standard.

Holdings in the valley should be not less than nine acres in area to allow for a long term rest in the rotations. Until rotations are established the nine acre holdings will tend to represent a system of shifting cultivation on a limited scale and in this way a great deal of damage cannot be done.

Rivi Rivi Farm

The Rivi Rivi food farm is situated in Balaka district on the south bank of the Rivi Rivi River close to its confluence with the Shire. The farm is readily divisible into six sections.

SOILS AND VEGETATION

1. The plain in the vicinity of the present farm has very little slope and there is difficulty in defining the drainage system.

(i) *Dark red-brown sandy clay loams*. A friable sandy clay loam soil with a sandier surface. Showing good water relationship and only rarely mottled at depth. Rain had penetrated very readily to 30 inches at time of survey. Characterized by a cover of *Pterocarpus angolensis* and *Combretum* sp. with *Commiphora excelsa*, *Albizzia harveyi* and *Lonchocarpus capassa*.

(ii) *Dark brown to strong brown sandy clay loams*. A nutty structured soil, loamy in the surface and mottled at about 20 inches. Adjacent to the dark red-brown sandy clay loams, but rain had not penetrated beyond 14 inches depth at the time of the survey. Vegetation is typified by *Sclerocarya birrea* with *Albizzia harveyi*, *Ostryoderris stuhlmannii*, *Combretum ghasalense* and *Adansonia digitata*.

(iii) Heavy soils of limited acreage in hollows and ill-defined drainage lines. These hollows are waterlogged in the rains and carry a cover consisting mainly of *Asteracantha longifolia*.

The three soil types given above apparently form a mosaic according to the microtopography and the variation between the first two types accounts for the unevenness in yields of crops grown in the large fields.

2. Bordering the flatter areas to the east and west are lands which have a slightly more pronounced drainage pattern.

The soils are *yellow red gritty clay loams* and border and merge with the dark red brown sandy clay loams. They have a cover of *Sclerocarya birrea*, *Pterocarpus angolensis*, *Ostryoderris stuhlmannii* with *Lannea discolor*, *Acacia nigrescens*, *Diplorhynchus* sp., *Terminalia sericea* and *Lonchocarpus capassa*.

These soils are cultivable and as such have been cultivated on part of the farm.

3. Towards the southern boundary of the farm is an area of uncultivable land comprising semi-swamp, seasonal swamp and stony areas.

(i) *Black clays* are found in the lower lying areas and may have quartz gravel at the surface. They are characterized by *Setaria palustris* and *Asteracantha longifolia*.

(ii) *Black clays* with large quartz fragments characterized by *Pterocarpus rotundifolius*, *Combretum ghasalense*, *Albizzia harveyi*, *Acacia* sp. and *Dalbergia melanoxylon*. These soils resist water penetration.

(iii) Intractable soils with shiny quartz and gravel on the surface, waterlogged in the rains carrying a cover of *Colophospermum mopane*.

Tongues of the *Colophospermum mopane* woodland are found on the southern boundaries of the farm fields.

4 To the north of the lands is an area carrying tall woodland and glade vegetation with *Euphorbia ingens* as a characteristic tree with *Sclerocarya birrea* and *Albizzia harveyi*.

5. More rolling and broken topography is found to the west and north.

(i) *Red brown gritty clays* of the ridges with *Pterocarpus angolensis*, *Lonchocarpus capassa* and *Ostryoderris stuhlmannii*. Sheet erosion is very common and the grass cover sparse.

(ii) On the colluvial slopes the soils become browner and slightly heavier with *Piliostigma thonningii*, *Combretum* sp., *Pseudolachnostylis maprouneifolia* and *Byrsocarpus* sp. Steep-sided gullies dissect this section of the estate, but with reasonable management small holdings could be laid out in the area. There is often a great deal of quartz in the soil and in some places quartz pipes reach the surface and form minor mounds and ridges. The area has been cultivated in the distant past from the evidence of old grinding stones and numerous pot-sherds.

(iii) There is a small area to the south of this section which carries *Julbernardia globiflora* woodland with *Diospyros kirkii*, *Azelia quanzensis*, *Annona chrysophylla* and *Terminalia sericea*.

The soil is very stony in the surface although ridges can be hoed up in it.

6. Towards the Rivi Rivi in the north of the estate the land becomes very broken with steep gullies.

The soils are brighter red in colour than other soils in the area being in the range 2.5 YR 3/6 dark red gritty clays. Where there are no cultivations there are dense thickets and tall trees, the thickets clothing the gullies and stabilizing them. The vegetation includes *Sclerocarya birrea*, *Ostryoderris stuhlmannii*, *Popowia obovata*, *Grevea bicolor* and *Combretum* sp.

Cultivators have now entered the area and have indiscriminately cultivated through the area and chopped out the vegetation in the gullies and are cultivating on the steep slopes in a haphazard manner. This is leading to spectacular erosion.

LAND USE

When the pattern of the soils of the flatter land is plotted it will be possible to lay out reasonable sized holdings and to avoid the wet hollows and sumps.

On the more broken land holdings will have to follow the pattern of the ridges and avoid the steep gullies and shallow, quartz dominated soils. Water supplies in this area will be more difficult than on the plain.

The black soils and the *Colophospermum mopane* dominated areas will be avoided for planned settlement.

Lambulira Village

Lambulira Village is in Zomba District and lies about eight miles south of Zomba township. It overlooks the Palombe Plain. The village lands are fairly broken and dissected by one major stream and several minor ones. To the west are rocky hills and there are several denuded rock outcrops in the area.

VEGETATION AND SOILS

The soil-vegetation pattern is complicated by the nature of the terrain and erosion pattern. Two main soil types are present.

(1) *Yellow red coarse sandy clay with murram* on the remains of an old land surface. A typical profile gives the following data:

0- 6"	7.5 YR 4/2	Dark brown sandy clay loam
6-12"	7.5 YR 4/4	Dark brown sandy clay
12-26"	5 YR 4/6	Yellow red coarse sandy clay
26-30"	5 YR 5/6	Yellow red sandy clay with murram
30-48"	5 YR 5/6	Yellow red with indurated laterite.

The vegetation is typical *Pseudoberlinia globiflora*-*Brachystegia* sp. woodland and the following species occur:

<i>P. globiflora</i>	<i>Brachystegia longifolia</i>
<i>Brachystegia utilis</i>	<i>Pseudolachnostylis maprouneifolia</i>
<i>Annona chrysophylla</i>	<i>Lonchocarpus capassa</i>
<i>Afrormosia angolensis</i>	<i>Dombeya rotundifolia</i>
<i>Bauhinia petersiana</i>	<i>Vitex</i> sp.

The soils are often shallow and rock breaks out at the surface in places.

Crops grown include cassava, groundnuts.

(2) The second main soil type is *dark reddish brown sandy clay on a red coarse sandy to gritty clay*.

0-15"		Very dark brown clay loam
15-23"	5	YR 3/3 dark reddish brown sandy clay
23-33"	5	YR 4/4 reddish brown coarse sandy clay
33-39"	2.5	YR 4/6 red very coarse sandy clay
39-60"	5	YR 4/6 yellow red soft rotting rock and soil mixed.

These soils are located on the slopes from the base of the hills to where there is obvious drift. Depth varies; in some places the soil being very shallow over rotten rock. Vegetation also varies and is difficult to define owing to extensive cutting over, but includes:

<i>Bauhinia petersiana</i>	<i>Piliostigma thonningii</i>
<i>Vitex</i> sp.	<i>Elephantorrhiza goetzii</i>
<i>Pterocarpus angolensis</i>	<i>Terminalia sericea</i>

These soils are fully cultivated and carry a large crop complex which includes air-cured tobacco and maize.

Other soil types are in relation to the two above.

(3) On lower slopes in association with the yellow red sandy clays are seasonal marsh *grey sands impregnated with clay* and mottled at depth. The vegetation is grassland with sedges.

(4) In the valley bottoms associated with the reddish brown soils are heavy black clays carrying *Phragmites mauritianus*, and *Pennisetum purpureum* with *Leersia hexandra* and *Paspalum commersonii* var. *scrobiculatum*. These soils are used as dry season "dimba" gardens, for out of season maize, vegetables and bananas.

(5) Higher on the slopes the black clay is overlain by wash from the reddish brown soils and one has a sandy loam overlying black clay, which soils appear to be very productive and are planted to maize and tobacco.

(6) In places lower down the slopes is a *yellow brown sandy clay* distinctly mottled at depth, particularly in areas where the stream has cut to rock bed.

(7) Very shallow soils overlying low rock outcrops. On the low rock outcrops are a number of plants which colonize early in the xerosere but organic matter does not accumulate because of annual fires. The rock outcrops often have many shrubs in association with them and includes *Holarrhena febrifuga*.

The streams are perennial and carry in places fine fringing forest with *Parkia filicoidea*, *Ficus* spp., *Adina microcephala* and *Albizia* sp.

REPORT OF THE PLANT PATHOLOGIST

The Plant Pathologist's report is given under the appropriate crop sections: Coffee, p. 114; Potatoes, p. 35; Tobacco, p. 42; Groundnuts, p. 28; Fruit, p. 124.

REPORT OF THE ENTOMOLOGIST

During the past year experimental work has been mainly concerned with the complex of insects generally referred to as the Maize Stalk Borer. This work is continuing during the present season so that many of the findings reported are interim in nature.

An experiment to investigate the usefulness of "Unifume" (Sodium n—Methyl Dithiocarbamate) in the treatment of tobacco seedbeds was carried out. Other entomological findings are not the result of formal experiments but emanate from observations made by the Entomologist during his advisory visits throughout the country.

Staff from the Entomological Laboratory assisted in the work of the Cotton Pest Research Scheme and the report of that work will be found in the Annual Report of the Scheme. No further specimens of the *Contarinia* from cotton, reported last year, have been found.

The following species are recorded as new to Nyasaland; two species may be new to science. Grateful acknowledgment is made to the Commonwealth Institute of Entomology for making the identifications.

COLEOPTERA

CARABIDAE

Tefflus carinatus Klug var. *violaceus* Klug

CETONIIDAE

Stephanorrhina princeps Oberth.

Neptunides polychlorous Thomas.

CURCULIONIDAE

Episus sp. unnamed in British Museum

Systates sp. unnamed in British Museum—on Mlanje cedar

LAMIIDAE

Ceropalesis taeniata Per.—on coffee

Tetradia lophoptera Guer

HYMENOPTERA

EURYTOMIDAE

Eurytoma sp.—on cotton

LEPIDOPTERA

PLUSIINAE

Plusia acuta Walk.—on tobacco

HEMIPTERA

PENTATOMIDAE

Halyomorpha viridescens Walk.—Damaging tobacco

APHIDAE

Cinara (*Cupressobium*) *tujafilina* del Guercio—on Mlanje cedar

The subject matter of the report is found under the appropriate Crop Sections: Maize, p. 18; Castor, p. 31; Coffee, p. 115; Tobacco, p. 45.

